Contents

MDNR/MDC Comments 2
Overarching Comment – Removal of Asian Carp from Analysis 2
Group I Comments (Operating Permits) 3
Group 2 Comments (Engineering) 16
Group 3 Comments (Bioassessment) 17
Group 4 Comments (MDC) 23
COMMENTS FROM EPA REGION VII 30
John Dunn comments: 30
Vanessa Madden, Comments 37

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Response to Agency Preliminary Comments on Labadie Energy Center §316(a) Draft Demonstration Study Report

Ameren Missouri has reviewed the comments provided by the Missouri Department of Natural Resources (MDNR) on behalf of the Agency and the Missouri Department of Conservation. It is our understanding that such comments also include feedback from Region VII of the United States Environmental Protection Agency (EPA) and the United States Fish and Wildlife Service (USFWS). Ameren also received comments from the EPA via email on December 4, 2019 from the MDNR. Ameren's responses to these comments are provided below. Some comments have also resulted in revisions to the Draft Demonstration Study Report and supporting materials (i.e., *Supplement to Labadie Energy Center Draft 316(a) Demonstration in Response to Agency Comments,* the "Supplement") which are referenced in the responses below. Ameren will plan to meet with MDNR in the near future to further discuss these comments and provide additional background.

MDNR/MDC Comments

Overarching Comment – Removal of Asian Carp from Analysis

The primary concern is the chosen Representative Important Species (RIS). The Asian Carp species should be removed from the RIS assessment, and the statistical analysis re-run. Significant changes will need to occur throughout the 316(a) document but this revision is essential for the final submittal. Rationale for this decision is provided below.

Also, the commenting entities are concerned with the statistical analysis, choice of data exclusions, and sampling methods, including but not limited to not following the sampling plan and requested revisions to the sampling plan. The commenting entities have reason to believe all of these questions can be cogently answered by Ameren prior to (or with) the submission of the 316(a) report.

RESPONSE: Asian carps (collectively "Asian carp") were selected as an RIS because they are a common nuisance species. One of the EPA criteria for selecting RIS (cited in Section 6.2 of the Demonstration) is "capable of becoming a localized nuisance species" (EPA 1974 and 1977). While we believe that Asian carp is an appropriate RIS for the LEC, we will remove Asian carp as an RIS in the predictive assessment (Section 6).

Commenters also requested that the statistical analyses in the retrospective assessment (Section 5) be redone without Asian carp. We do not believe that removing Asian carp is appropriate as they are now an established part of the fish community in the Lower

Missouri River (LMOR). Both the EPA guidance for 316(a) demonstrations (EPA 1974 and 1977) and EPA regulations (40 CFR, 125.73(a); 44 Fed. Reg. 32,952 (7 June 1979)) explicitly state that the indigenous community may contain non-native species so long as their presence is not due to the pollutant being addressed (in this case the thermal discharge) (this is also described in 3.3.1 of the Demonstration). Asian carp are now resident in the LMOR due to range expansion and not as a result of the LEC discharge and, therefore, should be considered part of the balanced indigenous community (BIC). Per EPA guidance, the 316(a) Demonstration is based on showing a balanced community and not a selected portion of that community. Therefore, removing a species that is part of that community would not be consistent with the objective of the Demonstration.

Further, because Asian carp comprised only a small fraction of the catch used in the retrospective analysis, its removal would not be expected to substantively alter any of the conclusions. Table 5-3 shows that silver carp, the most abundant of the Asian carp species, accounted for 1.7%, 1.4%, 2.4%, and 1.9% of the numerical abundance in the Upstream, Discharge, Thermally Exposed, and Downstream zones, respectively. Overall, the three Asian carp species accounted for only 2.2% of numerical abundance in the 2017-2018 sampling, and 16.3% of the biomass in the combined collection. However, to address agency concerns about potential bias to the analytical results, we provide supplemental material comparing community analyses with and without the Asian carp (see the Supplement).

Group I Comments (Operating Permits)

1. Page VII, zone of passage. The Department is asking Ameren to better evaluate the zone of passage. Provide data or references showing the zone of passage area is actually used by fish avoiding the thermally affected zone.

   RESPONSE: The EPA guidance for 316(a) Demonstrations requires that a zone of passage (region of temperatures less than avoidance temperatures that fish may use to traverse up or downstream past a thermal discharge) be maintained (EPA 1974 and 1977). We believe that the availability of a zone of passage has been successfully demonstrated (Section 6.3.3, Table 6-2). Studies to demonstrate that fish were using the zone of passage were not part of the approved Study Plan.

   The scientific literature demonstrates that fishes can avoid higher temperatures or other unfavorable environmental conditions and use alternate areas of the river. For example, a gravid female pallid sturgeon, tracked by telemetry in the LMOR near Boonville in late April 2010, was observed to select an upstream migration pathway that would minimize energy expenditure by repeatedly crossing the river to select slower velocities, while avoiding the higher current in the thalweg (*McElroy et al. 2012. Optimum spawning migration pathways.*

Ecology Vol. 93, No. 1). Because LEC's plume is restricted largely to the area of the thalweg, this fish would likely have avoided the plume due to its higher current velocities and sought the lower velocities, as well as the lower temperatures across the river. Furthermore, temperature sensitive species such as blue sucker tend to complete spawning migrations in fall and early spring prior to the occurrence of high summer plume temperatures (*Neely et al. 2009. Seasonal use distributions and migrations of blue sucker in the Middle Missouri River. Ecology of Freshwater Fish 2009: 18: 437–444*).

2. Section 1.2. The request is explained as requesting a 6% time of deviation from the Thermal Discharge Parameter (TDP) of 0.95 under the following circumstances: river flow is less than 40,000 cfs or ambient river is greater than 87°F. If either of these conditions occur, then the facility may be permitted to exceed the 0.95 TOP 6% of the time.

    a. How does the facility suggest these conditions be monitored; will data be obtained on an hourly or by minute basis?

    b. How will the facility determine the discharge is less than 40% of the river volume? And at what frequency? How will the area of zone of passage be calculated; how does the percentage of river used for mixing compare numerically to the zone of passage?

RESPONSE: Based on the 316(a)study data and associated analyses, Ameren has proposed a modification to the current NPDES permit effluent limitations in Table A-2 as follows:

A Thermal Discharge Parameter (TDP) value greater than 0.95 is permitted when upstream river flow is less than 40,000 cfs, or background river temperature is greater than 87°F. The size of the Mixing Zone shall be less than 40% during these conditions as calculated by the equation in Note 5. This exception shall not occur for more than 6% of the days in a calendar year.

As noted, the TDP permit limit exception could potentially be invoked on up to 6% of the days in a calendar year (i.e., 22 days), but only on days when background river temperature is significantly elevated (i.e., above 87°F), or when low flow is occurring in the river (i.e., upstream river flow is less than 40,000 cfs). For 94% or more of the days in any calendar year, the TDP permit effluent limitation of 0.95 must be met. It is anticipated that, based on historical data, in many years the requested 316(a) exception will never be invoked, and the TDP effluent limitation of 0.95 will be satisfied on all days in such years. Furthermore, whenever the exception is invoked, the allowable mixing zone would still be limited to a maximum of 40% of the river as compared to the standard allowable regulatory mixing zone of 25% of the river. At least, 60% of the river will still be outside the mixing zone providing a substantial zone of passage not dramatically different from the 75% normally required.

2a. The NPDES permit TDP effluent limitation is a daily average limitation. Compliance is measured and determined on a daily basis. Consistent with that, Ameren has proposed that the alternative 316(a) effluent limitation also be measured and determined on a daily basis, i.e., as noted above, the alternative 316(a) effluent limitation cannot be invoked on more than 6% of the ***days*** in a calendar year. While Ameren may collect data on a more frequent basis (e.g., hourly), permit compliance in this regard is based on daily average conditions. As noted in Ameren's 316(a) variance permit modification request, the alternate effluent limitation proposed by Ameren is substantively similar to the water-quality based final thermal effluent limitation in the permit. It would be inconsistent to introduce a time frame different from the current effluent limitation as it would no longer relate to the current effluent limitation from which relief is needed during extreme river conditions. The TDP would continue to be calculated every day of every year, and Ameren would be permitted to exceed the TDP effluent limitation of 0.95 on up to 22 days per calendar year, but only on days when the extreme specified river temperature and flow conditions are encountered. Furthermore, on those days, the size of the mixing zone as calculated by the approved equation in Note 5 of Table A-2 in the permit, must not exceed 40% of the river. Therefore, even on the days when a TDP greater than 0.95 is permitted, at least 60% of the river will be in compliance with Missouri's water quality standards for temperature.

2b. The equation in Note 5 of Table A-2 of the permit specifies how the size of the mixing zone is determined for any combination of river flow, river temperature, discharge flow and discharge temperature. The determination is completed on a daily basis along with the determination of the TDP. If we define the zone of passage as the portion of the river outside of the mixing zone, then it would be 100% minus the percentage of the river in the mixing zone as calculated by the equation in Note 5 of the permit's Table A-2.

3. Section 2-1 page 2-2, 4th full paragraph; the text references "MDNR 2015" however this reference is not found in Section 8. Please provide the corrected reference either to the text or added to the reference section.

   RESPONSE: The MDNR 2015 reference is correct. The date of the 2014 document in the reference section was incorrect and has been changed to 2015.

4. Section 3.3.3 last paragraph; the author indicated the remaining life of the plant was a consideration when assessing thermal discharge consequences.

   What is the remaining useful life of the plant? Is the plant expected to be retired sooner for any reason?

   RESPONSE: Section 3 solely provides the regulatory background and indicates that useful plant life can be a consideration according to the EPA guidance (EPA 1974 and 1977). In our analysis we did not use plant life as a consideration.

5. Section 5.4.1.1. The conclusion was made that winter abundance in the thermally affected zone indicated this zone attracted certain aquatic species and this conclusion also indicated there was no adverse effect. This statement may need additional citations or data showing how attracting species is not an adverse effect.

   RESPONSE: Fish attracted to the thermally exposed zone and discharge may have increased growth rates due to higher temperatures and higher densities of forage fish. Potential adverse effects of these fish being attracted to the discharge and thermally exposed zone are related to cold shock (i.e., a sudden decrease in temperature sufficient to cause severe thermal stress to aquatic organisms) associated with a complete shutdown of all units operating at the LEC. Section 6.3.1.2 of the Demonstration assessed the risk of cold shock for four of the seven RIS species with available information. In all cases, the lower incipient lethal temperatures (LILT) were less than the temperature exposures that would occur with complete shutdown of all units at the LEC (see Figures 6-12 through 6-15 of the Demonstration). These results indicate that there does not appear to be any potential for mortality associated with cold shock at LEC in the event of a shutdown of all operating units. Furthermore, the likelihood that all units would be simultaneously shut down at the LEC is exceedingly low. For these reasons, attracting fish to the thermally exposed zone and discharge during winter months is not considered an adverse effect.

6. Section 5.4.1.3 "Diversity". The first paragraph explains the metrics used to elucidate species indices from the raw data obtained in the LEC studies. A sufficient explanation was provided for Hill numbers and the Shannon index, but was not numerically explained for the Simpson concentration. Please explain how each of the indices were used in the following tables (pages 5-18 to 5-23) and how the tables are representative of the study. Additionally, please provide the equations showing the relationship between the Ho (number of species per Hill number); H1 (exponent of Shannon index); and H2 (inverse of Simpson index) used for this study.

   RESPONSE: The calculations of diversity used here are derived from the abundance-based analytics of Chao and Jost 2015. Assume that a collection consisting of S species with numbers of individual species denoted as n_1, n_2, n_3,....n_S. The proportion of the catch due to each species *i* is

$$p_i = \frac{n_i}{\sum_{i=1}^{S} n_i}.$$

   Hill numbers of order *q*, where *q* is a measure of the sensitivity of diversity to species abundance, denoted as ${}^{q}D$, are calculated as:

$${}^{q}D = \left(\sum_{i=1}^{S} p_i^q\right)^{\frac{1}{1-q}} \text{ where } q \geq 0, \text{ but } q \neq 1$$

Because the exponent $\frac{1}{1-q}$ would be undefined at q = 1, the limiting value as q→1 is substituted for equation [1]:

$$^{q}\mathrm{D} = exp\left(-\sum_{i=1}^{S} p_i \log p_i\right) \quad \text{where } q = 1$$

The calculations describe a continuous smooth relationship between $^{q}\mathrm{D}$ and q, given the particular values of p_i derived from the data. When most of the organisms captured belong to just a few taxa, the curve declines sharply from its maximum value (S) at q = 0. If the collection is more evenly dispersed among many taxa, the curve declines gradually. The diversity profile is interpretable as the number of equally abundant taxa that would be required to produce the same level of diversity at any particular level of sensitivity to abundance.

At q = 0, the diversity metric is completely insensitive to the relative abundance, and as would be expected, $^{0}\mathrm{D}$ is equal to the observed species richness (S_{obs}). When q = 1, the diversity metric is equivalent to exp(H') where H' is the Shannon-Weiner diversity. When q = *2*, the diversity metric is equivalent to the inverse Simpson index.

q	Special Cases of Hill Numbers at q = 0, 1, 2	Corresponding Metric
0	$^{0}\mathrm{D} = \left(\sum_{i=1}^{S} p_i^0\right)^{\frac{1}{1-0}} = \left(\sum_{i=1}^{S} 1\right)^{1} = S_{obs}$	Species Richness
1	$^{1}\mathrm{D} = exp\left(-\sum_{i=1}^{S} p_i \log p_i\right) = \exp(H')$	exponential of Shannon Diversity
2	$^{2}\mathrm{D} = \left(\sum_{i=1}^{S} p_i^2\right)^{\frac{1}{1-2}} = \frac{1}{\sum_{i=1}^{S} p_i^2}$	inverse Simpson Diversity

The referenced indices were only used in Figure 5-15 on page 5-22. These historical diversity indices (species richness, Shannon, Simpson) are represented in Figure 5-15 (page 5-22) as points on the continuum of the diversity profiles at q = 0, 1, and 2 respectively. Additional tables of diversity indices are provided in Appendix B of the Demonstration Study report (Tables B-6 through B-9).

7. Figure 5-14. Please provide the units for fish length.

   RESPONSE: The units (mm) have been added to the figure.

8. Section 5.4.1.3 "Presence of all Trophic Levels". It would be helpful to provide a table (such as was provided in 5-5) of the species and which categories they occur (herbivore, omnivore, planktivore, etc.).

   RESPONSE: A table showing the categorization of species into trophic levels has been inserted into Section 5.4.1.3. The categorization is based on Appendix A in Pearson et al. 2011. Multimetric Fish Indices for Midcontinent (USA) Great Rivers, Transactions of the American Fisheries Society, 140:6, 1547-1564.

9. Section 5.4.1.3 "Lack of Domination by Heat Tolerant Species".

   a. Please provide the rationale for accepting biomass data preferentially to numeric quantities of heat tolerant species. In preferring biomass, the study may be preferring a small subset of large individuals which generally have greater tolerance to changes in heat and may mask the differences in feeding behavior within the different sections in the river.

   b. According to the text, there were no heat intolerant species counted in the discharge and thermally exposed areas, but Figure 5-19 appears to show the opposite.

   c. In addition to this, please graph these by season as Section 6.3.3 indicates certain intolerant species will be completely absent if the river exceeds certain temperatures. Seasonal density graphs were completed for the macroinvertebrate community in Figure 5-24.

   d. Please provide the raw data of the heat intolerant and tolerant species for this section so further statistical analysis can be completed.

   e. Similarly, to assure population skewedness is not a factor, removing all data associated with Asian carp will better show how non-invasive species are distributed in the LEC's region of the LMOR. This is true for all data and graphs; however, as Section 6.2 suggests, Asian carp is a Representative Important Species (RIS), but in fact, an RIS should not be based simply upon abundance or universal presence. The EPA's 1977 316(a) Technical Guidance does not appear to address invasive species, or ecosystems dominated by a class of invasive species (such as the two identified species of carp). Please provide another reference or rationale showing an invasive species could be classified as one of importance.

   RESPONSE:

   a. Biomass was not preferentially used. The sentence has been revised to clarify.

   b. We have reviewed the text and cannot find the statement that there were no heat intolerant species counted in the discharge and thermally exposed areas. On page

5-29, the second paragraph under the sub-section "Lack of Domination by Heat Tolerant Species" starts "The abundances of heat intolerant species were similarly low in all zones."

c. Graphs in Section 5 were selected to illustrate patterns in the data, without overwhelming the reader with more graphics than can be assimilated. The seasonal aspect of the prevalence of heat tolerant and intolerant species was incorporated into the analysis. The data for tolerant and intolerant species, segregated by gear and season, are provided in Appendix B Tables B-14 through B-17. The standardized differences between Upstream and either Thermally Exposed or Downstream zones, based on each of these combinations for fraction intolerant species are provided in Appendix B Tables B-18 through B-21. All of the standardized differences for each combination of gear x season, for both numerical abundance and biomass (without preference) were included in the overall weight of evidence, along with differences based on other metrics, in Figure 5-22.

To satisfy the request, figures similar to Figure 1 are provided in the Supplement (Section 3) to demonstrate the seasonal component of heat-intolerant species as it relates to numerical abundance and biomass.

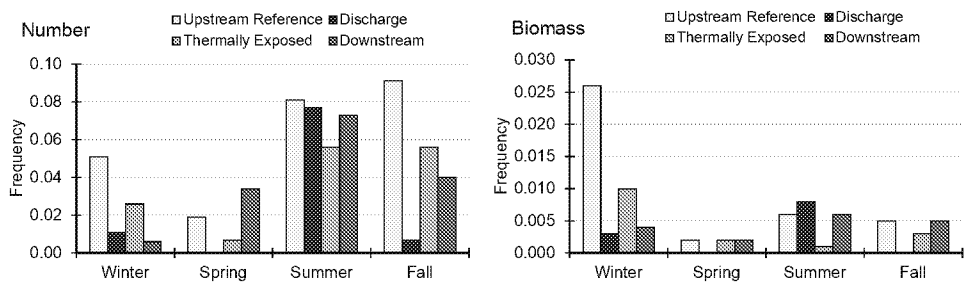

Figure 1. Seasonal fraction of the fish community comprised of heat intolerant species as numbers (left) and biomass (right) in the vicinity of the LEC in 2017-2018.

d. Heat intolerant species included sauger, walleye, mooneye, goldeye, and white crappie. Heat tolerant species included bighead carp, silver carp, bigmouth buffalo, smallmouth buffalo, channel catfish, flathead catfish, emerald shiner, gizzard shad, longnose gar, shortnose gar, and river carpsucker. As indicated in the response to 9(c), the data are summarized in Appendix Tables B-14 through B-17 of the Demonstration Study. Data for individual heat-tolerant and heat-intolerant species, are provided in the Supplement Table 10-1.

e. This question is relevant to two different analyses – the retrospective and the predictive. The removal of Asian carp from the retrospective analysis is addressed in response to the overarching comment (page 2). As indicated in the response, analyses were re-run by removing Asian carp. Results of the

analyses with Asian carp removed (see Section 2 of the Supplement) indicate that community composition is not notably altered from that described in the retrospective analysis of the Demonstration Study. As such, the agency's concern that the inclusion of Asian carp in the analysis would result in a skewing or masking of trends among other non-invasive taxa is not warranted.

Regarding the selection of Asian carp as a RIS, they have been removed from the predictive analysis in Section 6 as requested (see the response to the overarching comment on page 2),

10. Section 5.4.1.4 provides a plethora of data manipulations and graphs showing a standardized difference between the upstream reference section and the thermally exposed and downstream areas. This data should be presented with the removal of invasive carp species. Just as it is important to use sufficiently sensitive analytical methods to detect specific pollutants, species known to be affected by thermal pollution should be used to show if thermal pollution is a factor at this facility. Invasive carp are not effective detectors of thermal pollution, and given they are an invasive species, these data should be removed from all datasets as they appear to be positively skewing the standardized differences. Several assumptions are required when standardized difference is used to show population dynamics. These assumptions must be met for these statistics to be used. Please provide the assumptions met or not met when using the standardized difference test.

RESPONSE: As described in the response to the overarching comment (page 2), Asian carp is now part of the indigenous population of the LMOR and should be included in any community-based evaluation of the LMOR. However, in response to the Agency's request, the retrospective analyses without Asian carp are provided in Section 2 of the Supplement.

Standardized differences were used as part of a weight-of-evidence summary of the results of a great many individual analyses conducted as part of this Demonstration. The only "assumption" used in the analysis of the standardized differences is that the values being calculated (e.g. mean abundance, biomass, diversity, etc.) would adhere to the Central Limit Theorem and have a distribution that is asymptotically Normal. The use of this theorem is essentially universal in parametric statistical analysis and does not depend on the distribution of the underlying data.

We chose not to conduct hypothesis tests for either the individual metrics or for the combination of standardized differences across all of the gear and seasonal metrics. Our principal reason for not doing hypothesis tests was that statistical significance is an arbitrary concept, typically but not always set to use a probability of falsely rejecting a true null hypothesis of no difference (Type 1 error, or "α") of 0.05, which does not necessarily

correspond closely with biological significance, i.e. a biologically meaningful difference in the communities (also see response to Comment #11).

Instead, we presented a graphical summary of the data so that the reader can observe the totality of the information, and hopefully form an opinion about the ecological effect of thermal discharge. If the discharge had a biologically meaningful adverse effect, then the distribution of differences should be visibly shifted toward lower values, regardless of whether the distributions are appropriately described by a t-distribution, Normal distribution, or some other distribution.

Although a non-parametric test (Kolmogorov-Smirnov) is available to compare distributions without making assumptions about the particular distributions, we feel the most appropriate test for this situation, to the extent one may wish to do one (but see also response to comment 11), is to use the Mathews test (Mathews, G. V. T. 1974. On Bird Navigation, with Some Statistical Undertones. Journal of the Royal Statistical Society. Series B 36(3): 349-364). The test has three levels of "significance": 1) not obvious; 2) obvious; and 3) bloody obvious. The comparisons of the standardized differences appear to be level 1.

11. Section 5.5.2.2 narratively explains the community characteristics for diversity and dominance. However, the sections do not effectively compare the interrelationships between the upstream and thermally exposed zone, only the differences between the three different sampling events. Using an analysis of covariance, such as ANCOVA or another similar statistical method, should occur to compare the difference between and within the two groups. Page 5-62 describes the differences found in the upstream reference and the thermally exposed zones for heat tolerant species, again, it appears invasive species are dominating the data therefore small changes in resident non-invasive species cannot be shown graphically.

    RESPONSE: The comparison between the upstream reference zone and other zones (thermally exposed and downstream) was conducted using the most recent data and was the focus of the spatial analysis in the retrospective assessment. Only the most recent data on fish and benthic macroinvertebrate assemblages were used for this comparison as these data would inherently reflect any historical changes that may have occurred within the larger aquatic community as a result of broad/regional trends in the Missouri River, while also allowing for a defensible basis for spatial analysis of the effects of the thermal discharge. The temporal analysis discussed in Section 5.5.2.2 focused on changes that may have occurred within each zone over time. If any such changes occurred similarly in the Upstream Reference Zone and the Thermally Exposed Zone, then those changes would not be attributable to the thermal discharge.

Regarding statistical analyses, we considered a number of statistical approaches to examine these trends. ANCOVA may be considered as one approach. However, EPA (2000) does not support use of statistical hypothesis tests in stressor identification, stating:

> "However, the use of statistical hypothesis tests is problematic. Statistical hypothesis testing was designed for analyzing data from experiments, where treatments are replicated and randomly assigned to experimental units that are isolated from one another. The application of these tests to data from observational studies can result in erroneous conclusions." (EPA 2000, page 3-7)

As such, in our approach we followed EPA's guidance. The approach we used, while non-statistical, provides a thorough and robust analysis of the data that is sufficient to support our conclusions. The historical data (data prior to 2017-2018) are based on sampling in the Upstream Reference, Discharge, and Thermally Exposed zones. The Thermally Exposed zone is conceptually equivalent to the "mixing zone", where temperature criteria may be periodically exceeded, and some response of the fish community would be expected. However, without comparable data in the Downstream zone, i.e. outside the mixing zone, temporal analysis of harm of the LEC discharge is not possible.

As explained in the response to the overarching comment (page 2), we do not believe that removal of invasive species from the analysis is appropriate. However, analyses without Asian carp are provide in Section 2 of the Supplement.

12. Section 5.5.2.3 weighs the evidence of the data. Again, invasive carp are not an effectual tool to measure differences in the heat tolerant vs. intolerant species as they appear ubiquitously at the site. Temporal changes are not necessarily a good measure of differences in community although it is important to show if temporal variability is occurring over discrete periods of time, a comparison should occur between the two groups, upstream and the thermally exposed zone within each study. Again, an ANCOVA could be an appropriate measure of these differences.

    RESPONSE: As discussed in the response to the overarching comment ((page 2), we believe that Asian carp should not be removed from the retrospective analysis as it is part of the LMOR community, and its presence is not a result of the Labadie thermal discharge.

    For the same reasons provided in response to comment #11, we do not believe the use of ANCOVA is useful for this purpose.

13. Section 6 provides the overall assessment of the study. Due to the factors above, these summarized facts may no longer be relevant after the data has been revised and recalculated to show adjusted population indices. The study plan indicated Ameren would consult with the Department over which species should be chosen for RIS. Did this occur? We were in receipt of Addendum 2 dated May 2017 with Section 3.2 highlighted as "RIS

Evaluation". This appears to not be a final selection but instead was prefaced as "The final selection of RIS for the predictive biothermal assessment will be made in consultation with the MDNR." A response was not provided by the Department to Ameren for the specified document as a request was not made at the time. The DNR and MDC would have not selected Asian carp as a RIS.

RESPONSE: We believe this comment was meant to apply to Section 7 which is the Master Rationale and provides the overall assessment of the study (Section 6 is the predictive assessment). The results of the reanalysis without Asian carp are provided in Section 2 of the Supplement; the summarized facts and conclusions are still relevant and applicable.

Conferring with the MDNR was not conducted due to an oversight. We have provided our rationale for selecting Asian carp as an RIS in our response to the overarching comment (page 2). We understand the Agency's position and have removed the Asian carp from the predictive analysis in Section 6.

14. Page 6-12 provides the primary purpose of the predictive assessment as being able to predict the effect on a biotic community from additional heat sources. In the table for representative important species for the predictive assessment, Asian carp was chosen. The rationale provided was simply that is it a nuisance species. The author seems to be comparing their importance based on entrainment sampling at the LEC, however, again, abundance does not necessarily correlate to importance. It appears a more appropriate representative species should be based on the actual importance to Missourians who use the river for sport fishing or food sources; or as a prey base. Additionally, to provide comment as to whether this study provides for a balanced community, food chain species should also be considered; and lastly, appropriate inclusion of endangered species and species known to be temperature sensitive. Channel catfish, emerald shiner, gizzard shad, pallid sturgeon, walleye, sauger, and white crappie are all appropriate RIS. 40 CFR 125.72(b) indicates the facility should choose species used to develop water quality standards; Asian carp are not a species which has associated in-stream numeric standard protections in Missouri.

    RESPONSE: As described in the response to the overarching comment (page 2), Asian carp have been removed from the predictive analysis in Section 6, The other selected RIS meet the criteria of food chain species, endangered species, and temperature sensitive species as well as recreationally important species.

15. Section 6.3.2. Please provide references for assessments made and assumptions provided in this section for each species. How does the author conclude larger individuals are better for the balanced community when exposed to thermal pollution?

    RESPONSE: Citations for life history information provided in this section are provided in Section 6.2 where this information is discussed in more detail. Only information relevant

to the discussion of growth effects is summarized here. The conclusion was not that larger individuals are better, but that slightly earlier spawning and higher growth rates for some individuals would not represent an adverse effect.

16. Section 6.3.3. Sampling did not occur in the zone of passage. Does the author have any comment regarding the lack of sampling in this area? Can any data obtained in the study show the zone of passage is being utilized effectively by heat intolerant species and they are realistically avoiding the thermally exposed zone?

    RESPONSE: The approved study plan did not plan for sampling in the zone of passage. There were no data collected during the study to show the zone of passage being used, However, as discussed in Section 6.3.3, the whole cross-section of the river is available as a zone of passage for all RIS under typical conditions. Even during the worst-case modeled scenario in July, which occurred less than 1 percent of the time over the period of record, approximately 50 percent of the river cross-section would be available to all RIS as a zone of passage (Section 6.1.2, Figure 6-5). In addition, as discussed in the response to Comment 1, fish have been shown to avoid unfavorable temperatures and utilize alternate areas of a waterbody. The similarity in fish assemblages upstream and downstream of the LEC discharge also suggests that fish freely move throughout the river. Therefore, even in the absence of sampling data from the zone of passage, it is reasonable to conclude that even during the infrequent worst-case conditions, fish will use the zone of passage and other available areas of habitat for refuge.

17. Section 7, Rationales 9 and 10 have not been substantiated appropriately. Sampling in the zone of passage did not occur to assure these heat intolerant species can use these areas outside of the thermally exposed area as an avoidance area. The assumption needs to be quantified appropriately.

    RESPONSE: We believe that Rationales 9 and 10 have been substantiated appropriately. For Rationale 9, Section 6.1.2 and Figures 6-4 and 6-5 show that for the June model scenario, 3 percent or less of the modeled area could potentially experience temperatures of 90°F or higher. For the July model scenario, approximately 50 percent of the modeled area could potentially experience temperatures of 90°F or higher. All RIS avoidance temperatures (Table 6-2) are approximately 90°F or higher except for sauger which would not be present in the study area during the summertime. It is important to note that the percentages do not account for all the available habitats near the LEC. Consequently, the percentage of areas potentially experiencing temperatures above 90°F would be substantially less than the above values. In addition, the July model scenario represents potential conditions that may be experienced less than 1 percent of the time over the 17-year period of record. Based on this information, the area of potential habitat exclusion was not considered to be unacceptably large.

For Rationale 10, Section 6.3.3 demonstrates that under typical conditions, the entire river cross-section is available as a zone of passage for all RIS. Table 6-2 shows quantitatively the amount of cross-sectional area available for each of the RIS species (Section 7 is meant as a summary only) under the worst case scenario (July modeled scenario) which occurred less than 1 percent of the time of the 17-year period of record. Even during a worst case scenario, approximately 50 percent of the river cross-section would be available as a zone of passage for all RIS. Consequently, because the percentage of areas potentially experiencing temperatures above 90°F are either absent or are shown to be extremely limited both spatially and temporally, Rationales 9 and 10 are substantiated.

18. Section 7, Rationale 18. In the nutrients, bacterial contaminants, and dissolved oxygen concentrations, a statement was provided saying "there is little likelihood the relatively small increase in temperature will demonstrably increase the rate of' those enumerated contaminants. Can the author provide a calculation of the assessment to show numerically these are relatively small increases?

    RESPONSE: Figure 7-1 addresses the dissolved oxygen concentrations within the thermally exposed zone relative to the upstream reference zone. As noted in Section 7, there is no reason to expect the LEC's thermal discharge will have any effect on nutrients and bacterial contaminants in the LMOR owing to the small size of the area affected by significantly elevated temperatures and the strong currents sweeping bacteria and nutrients through the thermally exposed zones. There should be no exposure to elevated temperatures for the majority of the bacteria and nutrients passing by the LEC. Therefore, there is no potential for temperature-related effects. Further, most of any exposures that do occur will be in the order of minutes and unlikely to be of sufficient duration to elicit any effects.

19. Section 8. Please provide the following references digitally:

    a. Bevelheimer, 2008
    b. Bevelheimer and Coutant, 2004
    c. Bulleit, 2004
    d. Coutant, 1972
    e. DeLonay et al, 2012
    f. EPRI 2013
    g. Galat et al, 2005a
    h. Galat et al, 2005b
    i. McElroy et al, 2012

j. Mestil, 1999

k. Neill and Magnuson, 1974

l. Schramm, 2004 in Welcomme 2004

m. Stanovick, 1999

n. Tripp et al, 2019

o. Union Electric Company, 1976 and 1977

p. Wismer and Christie, 1987

q. Yoder and Emery, 2004 Group 2 Comments (Engineering)

RESPONSE: The requested references have been provided as part of this response to comments.

Group 2 Comments (Engineering)

20. Table 5-9 is electrofishing sampling from 1980-1985, 1997-2002, and in 2017-2018. Please address why the electrofishing results from Tables 24 & 28 from Volume 2, Attachment K from 1976 Labadie Thermal Discharge Effects on Biological Populations of the Missouri River were not included.

    RESPONSE: The early data were not used because we only had the reference tables which did not provide enough data for our analyses.

21. Section 2, it may be beneficial to include more description on the changes in the Missouri River over time and how the river is being used. See Volume 6 Attachment O and Volume 8 Attachments Q & R from 1976 Labadie Thermal Discharge Effects on Biological Populations of the Missouri River.

    RESPONSE: Additional description of the changes in the Missouri River over time and how it is being used has been incorporated into Section 2.1 of the revised draft Demonstration document.

22. Section 5.4, while the pallid sturgeon are specifically referenced as the only federally listed endangered species, Ameren should provide a discussion on any possible presence of state listed threatened or endangered species. The 2019 list from MDC is available at

    https://nature.mdc.mo.gov/sites/default/files/downloads/2019_SOCC.pdf

    RESPONSE: No federally listed endangered or threatened species were collected over the two-year survey period from 2017-2018. However, three state-endangered lake sturgeon (*Acipenser fluvescens*) were collected. One lake sturgeon was collected from the discharge in April 2018 and one individual was collected from the inside bend wing-dike habitat in

the upstream zone in both May and November 2018. In addition to these individuals several species having S2 "imperiled" or S3 "vulnerable" rankings of conservation concern in Missouri were collected including the plains minnow (*Hybognathus placitus*; S2; n = 6 individuals), sturgeon chub (*Macrhybopsis gelida*; S3; n = 78 individuals) and ghost shiner (*Notropis buchanani*; S2; n= 3 individuals) (Table 1). Five skipjack herring were also collected that have a Missouri ranking of SU "unrankable" due to lack of information or due to substantially conflicting information about status or trends (Table 1).

Table 1. Missouri Species of Conservation Concern Collected from each Sampling Zone and Habitat Type by all Gear Types in 2017-2018

Species	State Rank	Upstream Zone	Discharge Zone	Thermally Exposed Zone	Downstream Zone	Overall Total	Overall Percent
Sturgeon chub	S3	10		36	32	78	0.31
Plains minnow	S2	4			2	6	0.02
Lake sturgeon	S1	2	1			3	0.01
Ghost shiner	S2	1			2	3	0.01
Skipjack herring	SU	3		1	1	5	0.02

S1 - critically imperiled; S2 - imperiled; S3 - vulnerable; SU - currently not rankable due to lack of information

23. Provide justification on why the sampling plan was not followed.

RESPONSE: Ameren implemented the sampling plan as developed and collected all prescribed fisheries, benthic macroinvertebrate, water quality and sediment characteristic data as specified. We infer that this comment may refer to the other comments made by the Bioassessment Group regarding the macroinvertebrate taxonomy, subsampling, deployment of mid-depth and bottom-depth H-D samplers, and the calculation of benthic macroinvertebrate metrics. All of these comments are directly addressed below in detail for each comment.

The only area of the sampling plan that we have identified as not being followed is the coordination with the MDNR on the final selection of RIS which was an inadvertent oversight.

Group 3 Comments (Bioassessment)

24. The study plans reviewed by the Bioassessment Unit all have language indicating that final selection of representative important species (RIS) will be made in consultation with DNR. However, this unit has not been contacted regarding the Labadie project since our joint meeting with Ameren and Amec Foster Wheeler (AFW) in November 2016. The other two DNR people in that meeting were Jake Faulkner and Sam McCord; I do not know whether

they were consulted on the RIS topic after the November 2016 meeting, but the Bioassessment Unit has not been involved since then.

RESPONSE: We apologize for the oversight of not conducting the final step to have the final selection of RIS approved by the MDNR. As indicated in other responses, Asian carp has been removed as an RIS in the predictive analysis in Section 6 of the revised draft Demonstration.

25. Section 8. Please provide determination of relevance for the following references:
    a. Holland et al, 1971; how do blue crabs relate to species found in Missouri?
    b. Meldrim et al, 1974; how do the noted estuarine species compare to freshwater riverine species found in Missouri?

RESPONSE: These were among a group of references cited on the effects of temperature generally on thermal tolerance and metabolism and were not used in any analysis or tolerance value related to the Missouri River.

26. On page 5-41 Section 5.4.2.3 "Community Characteristics: Diversity," it states, "Due to the differences in taxonomic level (class, order, family, etc.) of identification of the benthic macroinvertebrates, diversity was calculated at the family level because most organisms could be identified to this level." This section goes on to describe differences in macroinvertebrate diversity among sampling zones, ultimately determining in the last sentence of the paragraph, "This analysis demonstrates that the LEC thermal discharge has not adversely affected the benthic macroinvertebrate diversity in the Thermally Exposed and Downstream zones."
    a. Basing diversity on family level identification can mask differences among stations, and this measure, as presented, lacks the precision to say definitively whether or not the macroinvertebrate community is affected by thermal discharge. It has been our experience that genera within a given family respond differently to pollutants. For example, some genera of mayflies are highly sensitive to heavy metals, whereas others are less so. In that scenario, the family is still represented, but there is no measure of the overall community being altered. Their study plan (Appendix A, page 11) and SOP (separate document) both state that identifications will be taken to the lowest practicable taxonomic level. If this level of effort was spent, why not base diversity measures on that? DNR protocols also require lowest practicable taxonomic level, but our biological metrics and criteria thresholds are not limited to the family level.
    b. Please provide the rationale for only identifying to the Family level.

RESPONSE:

a. As specified in the study plan, taxonomic identification was conducted to the lowest practicable taxonomic level. In response to this and other related comments regarding the benthic invertebrate analyses, we have included additional data and related analyses in the Supplement.

   Overall, for Hester-Dendy samples, 22% of organisms were identified to species, 65% to genus, and 12% to Family. For ponar samples, 16% were identified to species, 10% to genus, and 44% to family. ASA chose to analyze diversity at the family level as a compromise between being inclusive of as many organisms as possible and being able to do the analysis at a consistent level of taxonomic specificity.

   As a result of the comment, ASA has reconsidered this decision and has revised the diversity analysis to the lowest practical taxon level. This revision has allowed more individual organisms to be included, and provided a minimum estimate of the total number of species. The revised analyses have been incorporated the revised draft Demonstration document.

b. Taxonomic identifications were made to the lowest taxonomic level based on the guidance provided in the SOP document by Sarver 2016 (MDNR-ESP-209) entitled "Taxonomic Levels for Macroinvertebrate Identifications". A summary of the macroinvertebrate data with identifications to family level by gear type and by sampling zone is provided in tables 5-8 and 5-9 of the Demonstration, and to the species level in Appendix Tables B-22 through B-24.

27. The study plan (Appendix A) says on page 11 that samples will be subsampled to 200 specimens. The Bioassessment unit could not tell whether they subsampled Hester-Dendy and ponar samples to 200 specimens, but Table 5-6 shows a total of 71,594 individuals identified from Hester-Dendy samplers and 23,115 from ponar samples in 2017-2018. This table also has macroinvertebrate taxa presented both at the family and species level, which suggests that they may have identified specimens to the lowest practicable level, but did not present the data. The heading of "species" in Table 5-6 should be reconsidered, given that relatively few macroinvertebrates can be taken to the species level, especially as larvae. Please supply a response.

    RESPONSE: Consistent with the study plan, if Hester-Dendy and Ponar samples contained a large number of specimens then samples were split using a Folsom plankton splitter. Sub-samples were then processed until a minimum of 200 specimens were found. Counts for individual sub-samples were maintained in the event that multiple sub-samples were required to reach a total of 200 specimens or in the event that an initial sub-sample containing more than 200 specimens was split a second time. The identifications of specimens in the sub-sample that contained a minimum of 200 specimens was multiplied

by the appropriate split factor (2^x, where x = the number of times the sample was split) to obtain the total number of individuals in the sample and species composition.

Captions for Table 5-7 and 5-8 are revised to ""Minimum species", consistent with the identification to the lowest practical taxon. Within a family, the minimum number of species would include each identified species, plus one for each observed genus with no identified species. Use of "0" has been standardized.

28. DNR suggested Hester-Dendy (H-D) samplers be deployed on the bottom of the river as well as suspended in the water column (AFW initially proposed to deploy H-D arrays only at mid-column). Our rationale was that this dual deployment would determine whether suspended H-D arrays only sample the drift, rather than the community that actually lives in the benthos at each station. At the November 2016 meeting, Bill Elzinga (AFW) agreed to this dual deployment, and it was written into the Study Plan. Pages 10-11 of the study plan (Appendix A: Labadie Energy Center§ 316(a) Study Plan and Addenda in the August 8, 2019, Final Demonstration) state that one H-D array would be deployed for benthic sample collection, and one array would be set for mid-water column sample collection. At the end of one year, the two sets would be evaluated to determine whether to continue with the dual deployment.

    The Bioassessment Unit did not see in any of the reports that this was carried out, nor did we read anywhere in Addendum 3: Summary of Revisions to the Initial Study Plan an explanation for why it was not. Please address the topic and provide an explanation for why this revision was made.

    RESPONSE: Consistent with the study plan, both mid-water and bottom H-D arrays were deployed for the full two years of the study. The data were combined because there was no temperature stratification observed in the water column and the decision was made to combine the data to provide a better overall picture of the macroinvertebrate community at the sampling location.

    An analysis of macroinvertebrates collected separately from mid-depth and bottom-depth samplers is provided in the Supplement. Despite differences in depth profile and the possibility for suspended HD samplers to collect only drifting organisms versus those associated with the community that lives in the benthos, the overall taxonomic composition of HD samplers was very similar among depths (overall QSIT value = 87.14) for all locations combined over the two year sampling period. These results indicate that collections from mid-depth and bottom-depth samplers were essentially equal and representative of the same community.

    Consequently, the Demonstration results relied on a combined mid-depth and bottom-depth analysis of the HD samplers, which accounts for the entire macroinvertebrate community (i.e. drift and benthos).

29. Also on page 11 of the study plan it says, "Benthic macroinvertebrate habitat and community analysis will include, but may not be limited to the following metrics: density (#/m^2), taxa richness, dominant taxa, EPT index, Biotic index, Shannon diversity index, qualitative sediment characterization (percent abundance of particle types, Wentworth scale). The study plan goes on to say on page 12 that detailed information regarding sample processing and analysis can be found in the SOP and QAPP documents that accompanied the study plan.

    a. Density, "EPT Species," and "EPT Intolerant" are presented in Appendix B, Tables B-46 through B-49. The remaining biological metrics (taxa richness, dominant taxa, biotic index, and Shannon diversity index) are not presented in the report. Based on the study plan, we expected to see more biological metrics provided and discussed. Tables B-37 through B-49 present a great deal of information, but biological metric trends among stations is notably lacking. Please provide the trend analysis.

    b. The SOP concurs with the study plan in that specimens will be identified to the lowest practicable taxon. The QAPP has a section that discusses fish identification, but there is no such discussion for macroinvertebrate identification. Please supply a discussion for the macroinvertebrate discussion.

RESPONSE:

a. Calculations of most of the metrics identified in the study plan were included. However, it was considered inappropriate to discuss each metric individually for our analysis. Rather, we combined them into the standardized difference analysis as part of a Weight-of-Evidence evaluation of thermal effects. The trend analysis for the metrics combined is included in Figure 5-29. We did not initially calculate a biotic index because we did not think that metric was particularly appropriate to evaluate thermal exposure (i.e., tolerance values as originally developed were more an indicator of organic pollution and not thermal conditions). Additionally, after evaluating the sediment composition in the interim report, we did not believe that the analysis provided any useful information to the assessment so we did not include it in the final report.

In response to this comment we offer the following:

- The specific metrics and standardized differences derived from them are presented in the following locations in the revised demonstration:
    - Density — Table B-25
    - Diversity — Table B-26
    - Proportion in Major Groups — Table B-27

- EPT Species and Fraction — Table B-28
- Heat-Intolerance — Table B-30

Seasonal summary of metrics above used to calculate standardized differences

- Winter — Table B-31
- Spring — Table B-32
- Summer — Table B-33
- Fall — Table B-34

- In the revised Demonstration, the diversity metrics and standardized differences are recalculated at lowest practical taxon. Similarly, the biotic index values are presented in the attached the Supplement, Section 7.
- A qualitative sediment characterization (percent abundance of particle types) of individual macroinvertebrate samples collected by ponar grab as per the study plan are also included in the Supplement, Section 9.

b. A detailed discussion of the macroinvertebrate identification and QA/QC procedures followed can be found in the Supplement, Section 8. A brief summary of these procedures is provided below. A 10% identification check was followed for the QA/QC assessment of macroinvertebrate specimen identification. Ten percent of samples that were identified by each taxonomist were processed for a QA/QC check by a second qualified taxonomist. Subsets of ten samples were designated for the QA/QC check, with one of the ten samples randomly picked to be the QA/QC sample. The original taxonomist must correctly identify 95% of the organisms comprising the sample in order to pass the QA/QC check. If a taxonomist fails a QC inspection, then the remaining samples within that subset of ten samples will be re-examined by the original taxonomist and also undergo another QA/QC check by a second qualified taxonomist. If these samples continue to fail inspection, then previous samples identified by the original taxonomist will undergo QC checks until 95% accuracy is achieved. A reference collection of voucher specimens was also maintained and independently verified by another taxonomist, with outside verification by a third party as needed. Any rare specimens or specimens of threatened or endangered species required additional verification and were sent to an outside recognized taxonomic expert for confirmation.

30. This is a minor point, but in Appendix B, the List of Tables needs to be corrected. For example, the List of Tables shows macroinvertebrate data beginning with Table 8-31 (Abundance statistics for benthic macroinvertebrate community sampling for 2017-2018

LEC study by zone, and season). However, macroinvertebrate data are presented in Tables 8-37 through 8-49. There may be other errors, but we verified only the macroinvertebrate tables.

RESPONSE: A careful review of the Demonstration report has been conducted to identify and correct this and other similar editorial errors.

Group 4 Comments (MDC)

31. The Demonstration is intended to determine whether the alternative effluent limits for temperature will assure the protection and propagation of the balanced indigenous community (page I). According to page V of the report, EPA's indicators of Appreciable Harm include no increase in nuisance species." Indigenous species are described on page 3-3, and seem to include those endemic to a waterbody, but also those specifically managed (such as intentional stocking of sport fish). Per MDC's comment, the DNR is requesting a summary of the temporal aquatic community and how populations have changed over time.

    RESPONSE: Table 5-10 in the Demonstration provides a summary of the fish collected by electrofishing over all seasons and zones for the three study periods. The objective of the included temporal analysis was to evaluate whether changes that may have occurred over time in the thermally exposed and downstream zones also occurred in the upstream reference zone. If such changes have occurred, it could reasonably be concluded that those changes are not a result of exposure to the thermal discharge. As summarized in Section 5.5.2.3 the temporal trend analysis indicates that the fish community in the Thermally Exposed zone changed in ways similar to those in the Upstream Reference zone indicating no adverse effects from exposure to the LEC thermal discharge over time.

32. The Demonstration evaluated data collected on two dates (June 22, 2006 and July 21, 2006) over a 17-year period of record. The rationale described for these dates was they occurred during the most extreme conditions during the "most biologically active period"(page 6-2). June and July are the most biologically active periods but spawning can occur earlier. Please comment as to why spawning months were not included.

    RESPONSE: We selected these dates because they represented the highest TDP values (i.e., worst case) and would have been permit limit exceedances if the current permit had been in place. As such, they represent conditions during which there is the greatest possibility for a biological effect to occur. At other times and other spawning months, the thermal plume temperatures were within acceptable ranges due to a combination of ambient water temperatures and plant operation and did not approach thermal tolerance limits.

33. The report notes the "avoidance temperatures" of pallid sturgeon are "not known" (page V). Please establish if the avoidance temperatures of pallid sturgeon can be determined, either through literature search or other assessment.

    RESPONSE: After a thorough literature search, no additional references were found providing avoidance temperatures for pallid sturgeon.

34. As acknowledged in Table 2-11, the previous thermal exceedances occur in July, August, and November. The documented previous thermal exceedance months (July, August, November) are not aligned with the selected ·most biologically active period" demonstration dates (in June and July, referenced Page 6-2). By selecting demonstration dates in June and July, potentially important data would be excluded {August, November). Excluding these data might result in inaccurate conclusions. Consider evaluating for the months of previous thermal exceedance or justify more fully why August/November data were excluded.

    RESPONSE: The selection of those June and July dates applies only to the predictive assessment. Those dates were selected as they represented the most extreme high temperature scenarios during the spawning season (June) and throughout the season (July). With the exception of a single year, the historical record indicated that there were no exceedances of current thermal permit limits estimated in November. In months with no exceedances, no thermal effects are expected. At times in which temperature exceedances were predicted in November values were sufficiently low so as to not yield thermal effects.

35. A thermal variance for six percent of the year represents 22 days. If these days were consecutive, it could have a cumulative negative effect for fishery resources. Please provide the rationale for allowing 22 consecutive days of exceeding normal river thermal limits.

    RESPONSE: The need and request for an alternative 316(a) effluent limitation is based, at least in part, on study of the historical database between January 2002 and September 2017. Table 2 illustrates the dates on which a TDP greater than 0.95 was retrospectively calculated to have occurred. (Note that the TDP effluent limitation was not in effect during this period and the facility was in compliance with its then existing thermal effluent limitation.)

Table 2. Consecutive Periods with Retrospectively Calculated TDP > 0.95

Start Date	End Date	Number of Consecutive Days
8/1/2002	8/5/2002	5
8/21/2003	8/22/2003	2
7/19/2005	7/26/2005	8
7/18/2006	7/21/2006	4
7/29/2006	8/4/2006	7
8/8/2006	8/11/2006	4
11/17/2006	11/17/2006	1
11/20/2006	11/20/2006	1
11/25/2006	11/29/2006	5
7/6/2012	7/10/2012	5
7/17/2012	7/20/2012	4
7/23/2012	7/28/2012	6

Note that the challenging conditions typically occur in July and August when high river temperatures can occur. But they did not occur in every year. In year 2006, very low flow in November posed a challenge. As a result, there were a total of 22 days in 2006 (6% of the days in the year). This served as the basis for requesting an alternative 316(a) effluent limitation for up to 6% of the days in any calendar year.

The largest number of consecutive days that posed a challenge was 8 in July of 2005. In July 2012, fifteen days, though not consecutive, would have had TDP greater than 0.95. In the period July 17 through July 28 of 2012, 10 out of 12 days would have had TDP greater than 0.95, and July 21 and 22 would have had TDP values of 0.8 and 0.9, respectively, clearly close to 0.95. So, a potential to have more than 8 consecutive days (i.e., the maximum observed) with TDP greater than 0.95 exists. While Ameren does not expect to experience 22 consecutive days with TDP greater than 0.95, there is concern that the number of consecutive days will exceed the maximum observed in the data record (i.e., 8 consecutive days).

Whether 22 consecutive days with the Ameren discharge TDP greater than 0.95 will pose a detrimental stress on fishery resources is certainly not demonstrated. Even under the

worst case condition, 60% of the river will still be in compliance with the thermal criteria in Missouri's water quality standards. More typically the portion in compliance will be in the range of 65% to 75%. Without the variance, 75% will be in compliance. Consequently, there is not a dramatic difference in the amount of the river that will be in compliance when the variance limits are invoked versus the normal limits. A substantial zone of passage (i.e., greater than 60% of the river) will be available even under worst case conditions.

Furthermore, 22 consecutive days under the variance is substantially less than that which would be allowed under a provisional variance. The Missouri legislature has provided the Director of Missouri DNR the authority to grant a provisional variance from compliance in appropriate circumstances. Provisional variances can be granted for an initial period not to exceed 45 days. Thus, the State of Missouri already has a mechanism in place to allow a variance to extend more than twice as long as Ameren's 316(a) request.

We reiterate that the variance is a reasonable mechanism for extreme conditions when strict compliance with the thermal criteria in Missouri's water quality standards are not achievable without severe curtailment of electricity production, and the demands for electricity are such that reduction in the generating capacity of the Ameren Labadie facility would pose an unacceptable societal hardship. Therefore, Ameren respectfully requests that there not be a restriction on the number of consecutive days when the 316(a) variance can be invoked.

36. Information about the thermal limits of other sturgeon species included Age-0/1 lake and shortnose sturgeon that showed limits of 31-35 degrees C (87.8 - 95 degrees F). At the low end of the temperature ranges feeding behavior is impacted negatively and at the upper end can be lethal depending on previous acclimation temperatures and duration. In the fish hatchery setting, it has been reported that developmental issues among immature sturgeon may occur over 26 degrees C. Please provide an assessment of this consideration.

RESPONSE: The data and information cited in comment #36 will not affect the interpretation or conclusion of the Demonstration study. Studies have shown that every species, including sturgeons, has their own thermal limits, which also are affected by acclimation temperature, geographic location adaptations, and experimental procedures. Kappenman et. al. (2013) concluded that their experiments showed that pallid and shovelnose sturgeon have a higher thermal tolerance limit, higher thermal optima, and a wider range for embryo to larval development than other sturgeon species.

In addition, recent studies (Delonay et al. 2009; Braaten et al. 2010, 2012) indicate that the area of influence from the LEC thermal plume is well upstream of the most probable settling areas for pallid sturgeon in the lower Missouri River, and possibly well downstream

from prime spawning areas and early embryo development. The following references are provided in addition to the list contained in Comment 19.

Kappenman, K.M., M. A. H. Webb and M. Greenwood. 2013. he effect of temperature on embryo survival and development in pallid sturgeon *Scaphirhynchus albus* (Forbes & Richardson 1905) and shovelnose sturgeon *S. platorynchus* (Rafinesque, 1820). J. Appl. Ichthyol. 29 (2013), 1193–1203

Braaten, P.J., D.B. Fuller, R.D. Lott, M.P. Rugge;s. T.F. Brandt, R.G. Lagaer, and R.J. Holm. 2012. An experimental test and models of drift and dispersal processes of pallid sturgeon (*Scaphirhynchus albus*) free embryos in the Missouri River. Environ. Biol. Fish 93:377-392.

Braaten, P.J., D.B. Fuller, R.D. Lott, M.D. Ruggles, and R.J. Holm. 2010. Spatial distribution of drifting pallid sturgeon larvae in the Missouri River inferred from two net designs and multiple sampling locations. N. Amer. J. Fish. Mgmt. 30(4):1062-1074.

DeLonay, A.J., R.B. Jacobson, D.M. Papoulias, M.L. Wildhaber, K.A. Chojnacki, E.K. Pherigo, J.D. Hass, and G.E. Mestl. 2012. Ecological requirements for pallid sturgeon reproduction and recruitment in the Lower Missouri River. Annual Report 2010. U.S. Geological Survey Open-File Report 2012-1009, 51 pp.

37. An added challenge for fishery resources is the higher the water temperature, the lower the natural concentration of dissolved oxygen gas in the water at standard pressure. For example, at 35 degrees C, the 100% saturation point is around 7 mg/L; it is below 6 mg/L at 45 degrees C. Dissolved oxygen is needed for fish respiration. Also, as temperatures increase, fish respiration increases and consumes more dissolved oxygen. Please provide assurances the LEC discharge is not reducing the DO of the stream to levels which would injure fish, and how will this be monitored/reported.

    RESPONSE: We provided an analysis for DO concentrations within the plume in Section 7, Figure 7-1. The analysis shows that during the study's hottest months, the thermally exposed and downstream zones contained similar (and slightly higher) DO than the upstream zone. Further, DO concentrations in the LMOR are rarely at or near saturation levels. Hence, reductions in saturation levels related to temperature will not cause any loss of DO in the water.

38. Hydrographs for both the Hermann Gage and the Labadie Gage provide water temps that usually peaked in July-August around 30-32 degrees C. Ambient water temperatures naturally reach the feeding impact temperatures. Please comment how this will impact this study overall.

RESPONSE: The fact that ambient temperatures may reach feeding impact temperatures will not have any impact on the interpretations or conclusions of the Demonstration. Ambient water temperatures may reach 30-32°C during some summer months and thus meet or exceed optimum temperatures for feeding and growth for some species, particularly less thermally tolerant species. This naturally occurs for many wild fish populations. The typical response will include a temporarily reduced or zero growth rate until ambient temperatures fall once again within the optimal range. In cases of prolonged high temperatures that could influence survival as well, motile life stages such as juvenile and adult fish will seek available thermal refuge areas, as observed by Ameren studies of Coffeen Lake (ESE 1995). Ambient temperatures in these refuge areas may fall within or closer to the species' range for feeding and growth.

Environmental Science & Engineering, Inc. (ES&E). 1995. Coffeen Lake 1995 aquatic biota and water quality surveys. Prepared for Central Illinois Public Service. November 13, 1995. ES&E Project No. 5195-125-0400.

39. The Demonstration describes that pallid sturgeon would avoid the thermal discharge zone at Labadie, and would not use shoreline habitat most affected by thermal events. It should be noted that Labadie Plant is located on the outside bend of the Missouri River, where the thalweg occurs. As noted in page 6-39, the species is known to use deeper channel areas (a.k.a. the thalweg). Drifting larval pallid sturgeon would not have adequate motility to avoid thermal mixing zones, and this life stage of the pallid sturgeon is known to be carried in the thalweg. Please describe how pallid sturgeon larvae drifting in the thalweg/outside bend where Labadie discharges will be addressed.

RESPONSE: Most drifting sturgeon larvae would not be exposed to potentially lethal temperatures long enough to be affected, particularly during the high river flows and current velocities in the thalweg during their prime spawning months. Transit times are addressed for all RIS in Section 6.3.1.1, including pallid sturgeon.

40. The Demonstration describes not increasing the prevalence of additional invasive species {p. 6-7) as evidence that the demonstration period with thermal variances successfully operates without detriment to the fishery. We consider Asian carp an invasive species and do not stock them as a sport fish. They could be considered a nuisance species.

    a. Please provide the rationale for classifying Asian Carp fish species as native/indigenous.

    b. How would the analysis and conclusions change if the Asian carp were included in the nuisance species- fish group?

RESPONSE: We are not sure which section of the report is being referenced here. Page 6-7 is Figure 6-4 and has no discussion of invasive species. We believe we did classify the

Asian carp as an invasive, nuisance species and they were selected as an RIS based on that criterion in the EPA guidance (see response to overarching comment on page 2). If the MDNR/MDC can clarify exactly which section of the report they are referencing here, we may be able to better address this question.

41. If MDC had been consulted about this study, MDC would have recommended including commercial fish (bigmouth buffalo, etc.) since other groups were included (invasive, game fish, prey fish, endangered, etc.).

RESPONSE: The availability of sufficient thermal tolerance data for bigmouth buffalo has been investigated to determine whether or not bigmouth buffalo could be added as an RIS. A single relevant reference (Yoder and Emery 2003) was found. This reference provided thermal effects temperatures for adult bigmouth buffalo acclimated to 80 to 86 °F as listed in Table 3.

Table 3. Thermal effects temperatures for adult bigmouth buffalo acclimated to 80 to 86 °F

Factor	Temperature (°F)
UILT50	100.9
Upper Avoidance	95.0
Maximum Temperature for Acceptable Growth	93.4
Preferendum	91.2

The thermal effects temperatures provided in this study are generally equal to or higher than the thermal effects temperatures of the other RIS suggesting little if any potential for thermal effects to this species by the LEC's thermal plume.

COMMENTS FROM EPA REGION VII

John Dunn comments:

1. The limit of 0.95 TDP, defining a 5°F temperature increase with a 5% safety factor, is technically correct, but does not provide transparent information to the lay public. Permit limits and the variance request should be based on temperatures expressed as degrees °F as set in MDNR criteria.

   RESPONSE: This NPDES permit used an innovative approach in setting thermal effluent limitations. It specifies a daily average thermal effluent limitation of 0.95 for the Thermal Discharge Parameter (TDP). That includes a specific margin of safety of 5% (i.e., the limit could be 1.0 and still be protective of water quality), as well as other inherent conservative factors that were built into the effluent limitations derivation process that afford an even greater, although not specifically quantifiable, margin of safety.

   This effluent limitation is not expressed as a specific temperature in degrees Fahrenheit for the discharge. (In fact, prior versions of this permit also had an effluent limitation expressed in BTUs not temperature. For example, see the permit issued November 24, 2015.) In fact, a single temperature effluent limitation is not adequate to ensure compliance with the receiving water quality standards for temperature. The effluent limitations derivation process for this permit has demonstrated that it is not just the effluent temperature that is critical to maintain acceptable receiving water quality, but it is the combined effect of effluent temperature, effluent flow, upstream temperature and upstream flow that together determine compliance with the water quality standards. The TDP limits the combined effect of these four aspects of the discharge and the river on any given day. As such, compliance with the TDP effluent limitation ensures that the numeric receiving water quality criteria at the edge of the mixing zone for temperature (no greater than 90°F) and increase in temperature above background river temperature (no greater than 5°F above background) are met day in and day out. (Indeed, requiring compliance with the water quality standards is exactly how the final effluent limitations were written in prior versions of this permit. For example, see the permit issued November 24, 2015.) In lay terms, the TDP limits the discharge so that whatever conditions occur in the river on any given day, the river temperature at the edge of the mixing zone will not exceed 90°F or be more than 5°F above background. This is far superior to limiting the discharge to the same specific temperature every day because even if that temperature limitation was derived for some critical condition, there can always be a more critical condition and under that more critical condition, by definition, the river will not be in compliance with the 90°F or delta T of 5°F criterion.

So, the best way to explain the effluent limitation to the lay public is to say that it ensures, for all conditions, that the river will not exceed 90°F or delta T of 5°F at the edge of the mixing zone, i.e., it provides for complete compliance with the water quality standards and also includes safety factors. A static temperature effluent limitation can never do that.

2. Equations for deriving TDP are calculated to many significant digits but monitoring in the current permit is only required once daily. During heat events, stream temperature can vary by up to 1.5°F in a given day.

   RESPONSE: The equations for the TDP have coefficients with several significant digits, but the TDP effluent limitation itself is expressed to only two decimal places (i.e., 0.95). The number of significant digits for the equation coefficients is needed to ensure precision in the calculation. However, the final calculation of the TDP (TDP = M1/M2) should be conducted to only two decimal places consistent with the effluent limitation.

   The effluent limitation is indeed a daily maximum limitation, not an hourly or any other temporal limitation, and compliance is measured (calculated) on a daily basis. While measured temperature may vary by 1.5°F at a point in the river over the course of a 24 hour period, temperature spatially across the river can vary by more even without the Ameren discharge. Such fluctuations are a natural phenomenon. The interim and final effluent limitations have always been expressed as daily maximum limitations as noted above in the referenced permits. Shorter time frames would be impractical, and the daily average TDP effluent limitation ensures compliance with the water quality standards.

3. The permit should assure that monitoring precision matches up with the detailed nature of the modeling. It should be noted that the USGS gage at Hermann, the data source for the permit, monitors Flow and Temperature every 15 minutes. Temperature can be measured inexpensively by calibrated thermistors feeding data to a computer that calculates TDP and estimated temperature at the edge of the RMZ. Continuous monitoring at this frequency would generate unneeded data, but high frequency monitoring when variance conditions are approached could create important data sets for future consideration. In any case, all data used in the model equations should be time synchronized.

   RESPONSE: While the USGS gage at Hermann may provide useful additional information, the USGS gage at Labadie (as required by Notes 2 and 3 to Table A-2 of the permit) is used for specifying background river temperature and flow in this instance. Consistent with the permit requirements and the modeling which served as the basis for the permit, the TDP is calculated and reported on a daily basis using the daily flow and daily temperature measured at the Labadie gauge. This is consistent with the temporal specification of the effluent limitation as discussed above (i.e., it is a daily limitation and compliance is determined only on a daily basis). Shorter time frames (e.g., 15-minute or

hourly) may be considered for operational purposes, and Ameren does use its own flow and temperature instrumentation and statistical relationships in real time to check on how the TDP is trending throughout the course of each individual day. Ameren does not have access in real time to the 15-minute data collected at either USGS station (Hermann or Labadie). However, as the comment suggests, such data can be subsequently obtained and considered by Ameren, after QA/QC by USGS, for future consideration in assessing system response during critical conditions when variance conditions are approached.

4. Ameren has requested a temperature variance for up to 6% of days each year. In keeping with the precision of the model and the ability to collect data, the time of the variance should be measured in the unit of hours. The MDNR criteria for increased temperature in the Mississippi River are based on a percentage of time in the calendar year and would allow this unit of measure. This would avoid the judgement call of how to count fractional days when river temperatures are rapidly changing. Other states, such as Iowa, use this approach.

   RESPONSE: While different approaches may be used in different states, the specific approach for this permit is a daily effluent limitation, not an hourly limitation, and hence the 316(a) variance should be expressed in terms of daily discharge not hourly discharge. If the 316(a) variance is expressed in a time frame other than daily, then it would not be consistent with the effluent limitation. Indeed, it would not be a variance from the current effluent limitation, but rather a whole new effluent limitation. The permit's effluent limitation and any accompanying 316(a) variance must be applied on a consistent time frame, i.e., daily in this instance. Therefore, the request for the 316(a) variance is as stated in the comment, i.e., "up to 6% of the days each year". This will be consistent with the time frame over which the effluent limitation is applied and compliance with that effluent limitation is reported. Introducing a separate time frame for the 316(a) variance may be possible, but it certainly would be cumbersome and confusing and will not be consistent with the way in which the effluent limitation was derived. Therefore, it must also be expressed and reported on a daily basis.

5. Is the calculation for the 40% Mixing Zone the same as for 25% Mixing Zone as defined in Note 5 in the current permit? Would cold temperature/low water events change this calculation? **Note 5: Mixing Zone (As Percent of Total River Flow) shall be calculated using the following equation: Mixing Zone = [0.1857 ln (M1 / M2) + 0.234] * 100**

   RESPONSE: The equation in Note 5 to Table A-2 of the permit (and as cited in the comment) is applicable to the calculation of the size of the mixing zone on any given day. It was derived from a series of model simulations with mixing zones ranging from 11.5% up to 45.7%. So, caution is suggested if applying the equation outside of that range. The equation was first presented in Figure 5 of *Supplemental Report Thermal Plume Modeling and NPDES Permit Effluent Limitations for the Ameren Labadie Energy Center Missouri State*

Operating Permit No. MO-0004812 prepared by Kleinfelder, February 10, 2017. In the current permit, the size of the mixing zone is implicitly limited to 25% of the river flow (see Note 4 to Table A-2). Calculation of the size of the mixing zone on a daily basis with the equation in Note 5 of Table A-2 is a monitoring requirement only. If compliance with the TDP effluent limitation of 0.95 is achieved on any given day, then compliance with a 25% mixing zone will also be achieved on that same day and will be demonstrated by the mixing zone equation in Note 5.

Based on the data record and potential extreme conditions in the river, there will be days when compliance with the TDP effluent limitation, and hence the 25% mixing zone requirement, cannot be achieved short of shutting down the facility. Consequently, Ameren is requesting a 316(a) variance for these extreme conditions. The request seeks relief from the TDP effluent limitation on up to 6% of the days in any calendar year. On those days, Ameren is willing to restrict the size of the mixing zone to 40% of the river flow, thereby leaving 60% of the river flow in compliance with the thermal water quality standards. The size of the mixing zone during those days can be calculated with the equation in Note 5. As derived, the equation is applicable on a year round basis regardless of temperature or flow in the river or the discharge.

6. The MO Water Quality Criteria for the Missouri River do not allow for any exceedance of temperatures above 90 degrees F instream: 10 CSR20-7.020(4)(D)(1). Criteria for lower sections of the Mississippi River, 10 CSR20-7.020(4)(D)(5), also require a 90 degrees F maximum, but do allow for a 5% time of exceedance and a maximum exceedance temperature of an additional 3 degrees F (93 degrees F at the edge of the RMZ). Mixing zones are set for both rivers at 25% at 10 CSR20-7.020(4)(D)(6).

   RESPONSE: Ameren's request for a 316(a) variance would allow a mixing zone up to 40% of the river flow on up to 6% of the days in a calendar year. The 90°F maximum temperature and delta T less than 5°F would be met at the edge of this mixing zone. Consequently, at least 40% of the river will have temperature less than 90°F and delta T less than 5°F. This is slightly different from although similar to the exception for the Mississippi River currently in Missouri's water quality standards.

7. The Ameren variance request appears to be based on the logic of the Mississippi River criteria and this seems appropriate. The questions/comments below are based on that approach. While variable with river temperature, what is the more elevated temperature (>5°F) at the edge of the 25% mixing zone when the RMZ is expanded to 40% of the river? Does this equate to an additional 3°F increase above 90°F? Is the 40% value based on a calculated zone of passage or a maximum temperature at the higher RMZ? Ameren's variance request should define the increase in temperature above 90°F when the larger RMZ is allowed.

RESPONSE: On days when the 316(a) variance is invoked, the 90°F and delta T less than 5°F requirements will always be met within a 40% mixing zone, but on those days the temperature will be either be (a) above 90°F or (b) more than 5°F above background in a 25% mixing zone. Hence the need for the 316(a) variance.

In response to this comment, we analyzed the model output from a subset of the previously conducted simulations that were run to develop the effluent limitation equations in Tables A-1 and A-2 of the NPDES permit. For each simulation, we determined the location along the river where the maximum temperature occurs after mixing with only 25% of the river flow. At all other locations, the temperature would of course be less than the maximum. The simulations analyzed represent a range of river and discharge temperatures and flows.

The results for the maximum temperature at the edge of the 25% mixing zone for each simulation are provided in the attached Figure. As expected, the Figure demonstrates that the maximum temperature is a function of the TDP. (Recall that the TDP is a composite measure of the combined effect of river and discharge flows and temperatures.) As can be seen, the maximum temperature at the edge of the 25% mixing zone will exceed 90°F at TDP values above 1, again as expected and as we have previously demonstrated. Nonetheless, the Figure further demonstrates that maximum temperature at the edge of the 25% mixing zone will always be below 94°F even for a simulation with TDP as high as 2.87. Analysis of the historical database (January 2002 – December 2018) indicates that TDP never would have exceeded 2.65. So, even when the variance may be invoked allowing temperature in the river to exceed 90°F in up to 40% of the river, the temperature will still be below 94°F in 75% of the river (i.e., be above 94°F in only 25% or less of the river), and will be below 90°F in 60% of the river (i.e., above 90°F in only 40% or less of the river). Furthermore, these maximum percentages will occur for only a small segment of the river and will be less at all other locations in the river.

For most instances during which the variance may be invoked the maximum temperature at the edge of the 25% mixing zone will only be one or two degrees above 90°F. For example, as shown in Figure 2, for a TDP value of 2.3, the maximum temperature at the edge of the 25% mixing zone will still only be about 92°F. And, TDP values at or above 2.3 would be extremely rare. The historical record shows that such has occurred on only 4 days out of 6018 days (less than 0.1% of the time). So, on days when the variance will be invoked, the maximum river temperature at the edge of the 25% mixing zone will typically be around one and almost always less than two degrees above 90°F, but never above 94°F.

The size of the mixing zone can be calculated on any day via the equation already in Note 5 to Tables A-1 and A-2 of the NPDES permit. Using this equation, a 40% mixing zone is needed when the TDP value exceeds approximately 2.5. Based on the historical data record cited above, the maximum TDP that would have ever occurred is 2.65. Values above

2.5 have occurred only twice, and Ameren is willing to accept a 40% limitation on the extent of the mixing zone for any day during which the variance may be needed. For most days when the variance will be needed, the size of the required mixing zone will be less than 40% and much closer to 25%. So, the 40% value is based on the historical record and represents the maximum size of the mixing zone needed. Typically, and throughout all of most years, a 25% mixing zone will be sufficient. But even during those times when a variance is needed, the mixing zone will not be much greater than 25% and never greater than 40% for only a limited segment of the river.

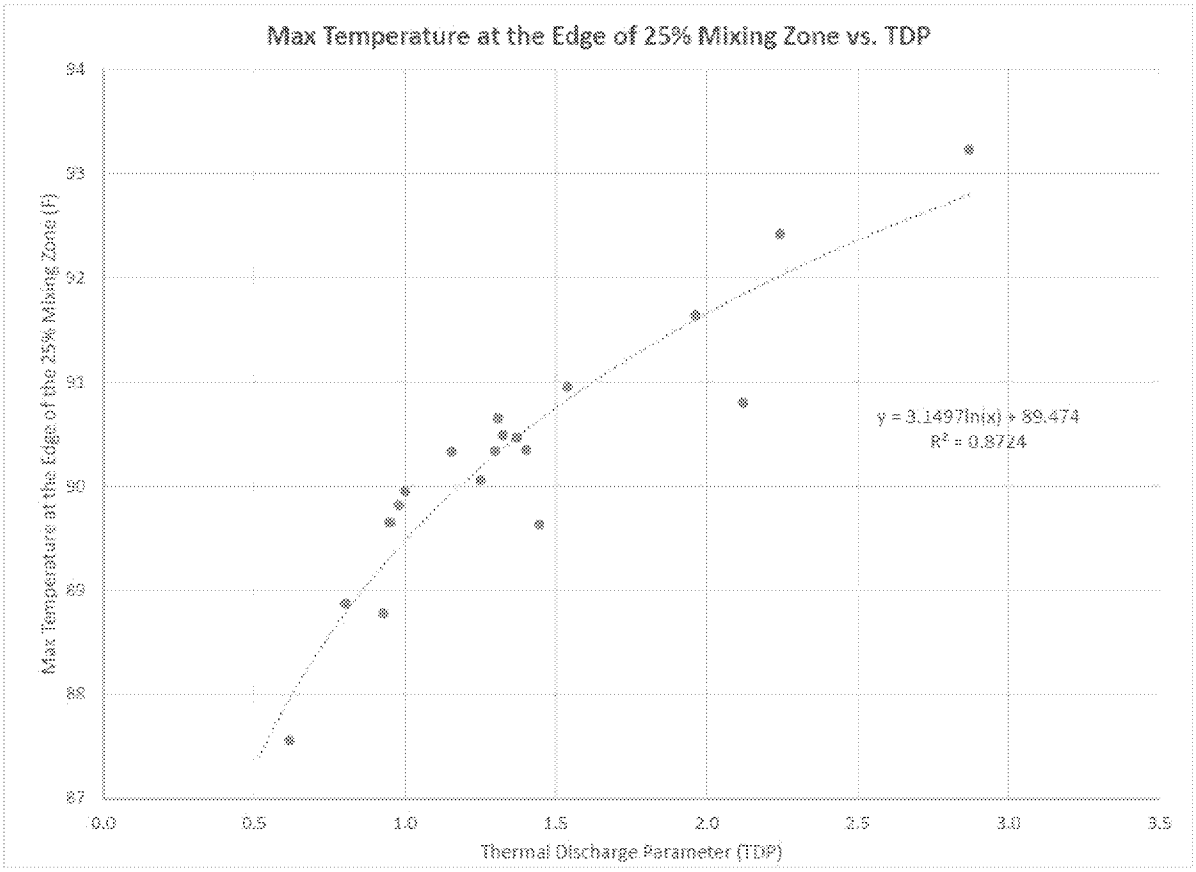

Figure 2. Maximum temperature at the edge of the 25% Mixing Zone vs. TDP

8. Ameren requests that the size of the RMZ be increased when river flows are less than 40,000 CFS. Based in 62 years of USGS data, the 25%-tile of flow at the Hermann gage is 39,200 CFS. Ameren has requested a 6% time of exceedance. It is not clear to EPA why the 40,000 CFS flow was chosen as a cut-off when this is a fairly common condition.

   RESPONSE: The request for a 316(a) variance on up to 6% of the days in any calendar year is based on retrospective analysis of actual conditions. For example, in the year 2006, a TDP of 0.95 would have been exceeded on 6% of the days. The extensive study that

Ameren has conducted in connection with this request has demonstrated that there has been no appreciable harm to the balanced indigenous biological community due to historic discharges from the Facility. Therefore, allowing a variance frequency consistent with the historical data is supported and will ensure the protection of a balanced indigenous community in the lower Missouri River. In other words, continued discharge from the facility at the same level as that which has historically occurred will not result in future appreciable harm to the balanced indigenous community.

If river flow goes below 40,000 cfs and river temperatures are near but below 87°F, a TDP greater than 0.95 will occur with all electric generating units operating at the Ameren Labadie facility. The same will be true if river flow is above 40,000 cfs and river temperature is above 87°F. Hence, the request for a variance when either of these conditions occur.

Regarding the frequency at which a flow less than 40,000 cfs will occur, any statistical analysis should be based on flows at Labadie not at Hermann. Furthermore, historical flow gauge data at Hermann are impacted by upstream reservoir regulation at least since 1958, and gauge data before then should not be used to calculate conditions representative of the present. River flows at Labadie have been reconstructed by Ameren since 2002, the point in time at which detailed information has been collected by Ameren at the location of the current Labadie gauge. Considering those data, a flow of 40,000 cfs is exceeded approximately 14% of the time. It makes sense that the percent frequency for a 40,000 cfs flow should be less at Labadie than at Hermann since Labadie is downstream and would have higher flows than at Hermann on corresponding days. But regardless of the frequency of the flow, the request for variance is still for only a maximum of 6% of the days in a calendar year. In nearly all years the number of days for which a variance will be needed will be less than 6% and for many years there will be no need for a variance. The 6% variance is requested to cover the worst case condition based on the historical data since 2002.

9. How would MDNR assess compliance with the variance-based limit? If limits and the variance are based on the Mississippi River model, there are other examples of permit approaches in other states.

   RESPONSE: We do not specifically know which permit approaches in other states the commenter is referring to. The Ameren permit has a somewhat novel approach with the TDP effluent limitation. We do not think that should be changed or compromised to accommodate approaches in other states. However, if there is something applicable that the commenter thinks we should consider, we are willing to do that. But, the current permit construct is very amendable to assessing compliance with the variance based limitation. During almost all days (at least 94% of the time), Ameren will comply with the TDP effluent limitation of 0.95. When a TDP of 0.95 is exceeded, as long as river flow is less than 40,000 cfs or background river temperature is greater than 87°F, the variance

based limitation will become effective. On those days, the TDP limitation will be ineffective and the permit limitation will be that the mixing zone shall not exceed 40% as calculated by the equation in Note 5 of Table A-2. The total number of days on which the variance based limitation can be effective is limited to no more than 6% of the days in a calendar year.

10. EPA suggests annual reports with electronic spreadsheets providing the raw data and calculations of TDP and temperature at the edge of the RMZ when the variance is utilized. These detailed data sets could be of long-term use as the variance is renewed over future permit cycles.

    RESPONSE: Ameren is amenable to the preparation of annual reports pending details. Ameren already provides spreadsheets with the raw data and calculated daily TDP when submitting its monthly DMR. Ameren will continue to do so for all days including those when the variance is utilized. The spreadsheet could be expanded to include a calculation of the temperature at the edge of the RMZ when the variance is utilized based on the equation cited above in the response to Comment 7.

Vanessa Madden, Comments

General Comment

The fish assemblage in the LMOR in the vicinity of the LEC were sampled during the two-year sampling program using bag seines, electrofishing, hoop nets, and Missouri trawls. Macroinvertebrates were sampled using Hester-Dendy samplers which collect drifting organisms, and a Ponar dredge, which collects benthic infaunal organisms. This overall sampling approach for fish and macroinvertebrate monitoring appears to be adequate to provide an overall assessment of the biological community in the vicinity of the LEC.

RESPONSE: Acknowledged

Specific Comments

1. **Table 5-3**. In addition to the graphical representations of the total abundance of fish, a more detailed evaluation would include the pattern of dominant and important species across the four zones.

   RESPONSE: In addition to the listing of the top 15 most abundant species in each zone in Table 5-3, Table 5-4 presents the top 5 most abundant numerically and by weight for each zone. Catch data are broken down by sampling gear in Figure 5-12 (summer) and 5-13 (winter), by length in Figure 5-14, diversity (summer) by zone and gear in Figure 5-15, dominance by zone in Figure 5-16, fish trophic levels by zone in Figure 5-17, major fish

types by zone in Figure 5-18, fractions of heat-tolerant and intolerant in Figure 5-19, and fractions pollution-tolerant and intolerant in Figure 5-20. Additional quantitative information, including for combinations of season, gear, and zone not presented in figures, is is provided in Appendix B of the Demonstration report.

2. **Section 5.4.1.3**. This section addresses the Asian carp with respect to increases in nuisance species. Silver (Asian) carp accounted for 1.7 percent of the catch in the Upstream Reference zone, 2.4 percent in the Thermally Exposed zone, and 1.9 percent in the Downstream zone (Table 5-3). Their contribution to total fish biomass ranged from 10 percent in the Upstream Reference zone to 12 percent in the Thermally Exposed and Downstream zones (Table 5-4). Although the differences are slight, there does appear to be an increase in Asian carp in areas affected by the LEC. An additional sentence should be added stating that slight increases in the number and biomass of Asian carp were observed in areas impacted by the LEC.

   RESPONSE: A sentence has been added on page 5-26 to note the small differences though we do not believe those differences to be biological meaningful (they are likely within the range of natural variability), nor would they be considered to constitute an adverse effect.

3. **Section 5.4.1.4**. The §316(a) demonstration is a weight of evidence approach that uses an overall pattern of standardized differences (similar to a t-statistic) across all the metrics to determine if there are any overall thermal effects. For fish and macroinvertebrates, they compared the thermally-influenced zone to the upstream zone and the downstream zone to the upstream zone. For fish, slight degradation was found in the comparison between the thermally-influenced zone and the upstream zone; whereas, a slight improvement was found between downstream and upstream zones. For macroinvertebrates, a slight degradation was found in comparison between the thermally-influenced zone and upstream as well as the downstream and upstream zones. It would be informative to see individual t-tests for some of the metrics, including abundance (numbers), diversity (numbers), fraction non-rough (numbers), and fraction heat tolerant (numbers). Heat tolerance is more important than pollution tolerance in relation to the impacts from the LEC. Moreover, combining numbers and biomass can mask some of the specific community level effects.

   RESPONSE: The individual metric comparisons (standardized differences) are essentially t-statistics and are presented in the appendix tables. Although each value could of course be compared to a critical value for a t-statistic with the appropriate degrees of freedom, we don't feel it is desirable to do hypothesis tests at this level of analysis. The EPA, in its 2000 Stressor Identification Guidance Document, specifically cautions against using statistical hypothesis testing in this context. One reason is that there are so many metrics that consideration of multiple testing and false significance rapidly arises. On a more

fundamental level, the relevance to any conclusion about the state of the biological community on the basis of statistical significance of any specific metric is dubious. We feel it is more appropriate to look at the whole distribution of the standardized differences, as was done in the weight of evidence sections, to assess whether harm is being caused by the thermal discharge.

4. **Section 5.4.2.** The Ponar and H-D macroinvertebrate sampling methods provided very different results. Similar to the fish results (which are based on combined sampling gears), an evaluation of the combined macroinvertebrate data from the Ponar and H-D samplers is recommended to gain a better overall picture of the macroinvertebrate community in each zone.

   RESPONSE: The fish results were combined across sampling gears for some of the data presentations, but analyses leading to the standardized differences were conducted separately for each gear. As with the fisheries sampling gears, Ponar and H-D sampling methods show different results because they are sampling different components of the macroinvertebrate community, but results from both gear are included in the weight of evidence approach taken to determine if the LEC thermal discharge resulted in adverse effects to the community. The Ponar and H-D based metrics in Appendix B Tables B-31 through B-34 (of the revised demonstration) were included in the overall analysis in Figure 5-29.

5. **Section 6.3.3**. Based on avoidance temperatures, the entire cross-section of the water column is available for passage for Asian carp, channel catfish and emerald shiner. For gizzard shad and white crappie, approximately half of the cross-sectional area in the vicinity of the LEC would still be available for passage under the worst-case conditions. Under more typical operations, no blockage would be expected for these species. To fully characterize the zone of passage, any future monitoring within the zone is recommended. For the more heat tolerant species, monitoring should occur when the zone is expected to be most limited.

   RESPONSE: This comment is acknowledged.

6. For walleye and sauger, use of areas near the LEC are limited to spawning migration during late winter and early spring. Blockage of migration in the zone of passage is not expected to occur. Similarly, for pallid sturgeon migratory blockage is not expected. To fully characterize the zone of passage with regard to the more heat intolerant species, any future monitoring within the zone during migratory periods is recommended.

   RESPONSE: This comment is acknowledged.