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May 2, 2016

Mr. Albert E. Hindrichs
Louisiana Department of Environmental Quality
Office of Environmental Assessment
PO Box 4313
Baton Rouge, LA 70821-4313
Al.Hindrichs@LA.GOV

RE: Public Comments on Draft 2016 Integrated Report on Water Quality in Louisiana

Dear Mr. Hindrichs,

I am writing on behalf of the Gulf Restoration Network and its thousands of members and supporters that care about the waters and wetlands of Louisiana. We offer the following comments and questions regarding the Draft 2016 Integrated Report on Water Quality in Louisiana into the public record. We look forward to your response to these comments, including the expert testimony of Dr. Joann Burkholder, attached.

1. Subsegment LA120806_00 (Coastal Terrebonne) inappropriately downgraded from IRC 5 to IRC 1

Since 2008, Louisiana has been attempting to remove the Dissolved Oxygen (DO) impairment from Gulf nearshore waters (subsegments LA070601_00, LA021102_00, and LA120806_00), despite the impact the nutrients from the Mississippi River, Atchafalaya River, and other sources within Louisiana. The Dead Zone has (a hypoxic zone in the Gulf that impacts Federal and State waters) been a major environmental issue for the country for decades, and it is disheartening to see the most recent attempt to remove LA120806_00 from the Impaired Waters List.

A. Louisiana disregarded data from sister agencies, as well as well-known data from NOAA/LUMCON

In 2015, the Louisiana Department of Wildlife and Fisheries (LDWF) submitted data to the NOAA Hypoxia Watch project[1]. This data shows that DO levels get well below 5.0 mg/l well within subsegment LA120806_00. In a map that overlays LDEQ subsegments and LDWF's data, you can easily see that the DO criteria was exceeded. See Exhibit A. Also, these surveys did not go all the way up to the shore, but it can be assumed that one could extend the contours, implying that there is even more of an area of low DO within the subsegment.

As we have put forward many times in comments on the Integrated Report, data from the Louisiana Universities marine Consortium (LUMCON) and the National Oceanic and Atmospheric

[1] http://www.ncddc.noaa.gov/hypoxia/, accessed May 1, 2016.

Administration (NOAA) monitor the Gulf every year for dissolved oxygen, mapping out the Dead Zone (an area of > 2.0 mg/l oxygen). These data and maps are published every year and demonstrate that the Dead Zone itself reaches into Louisiana waters, like subsegments LA070601_00, LA021102_00, and LA120806_00. Further, according to LAC 33:IX.1113.C.1," the statewide dissolved oxygen (DO) values represent minimum criteria for the types of water specified." For these subsegments, the criterion is 5.0 mg/l (LAC 33:IX.Table 3). Therefore even if the Dead Zone (<2.0 mg/l DO) barely makes its way into one of these segments, it is logical to assume that the area between 2.0 mg/l and 5.0 mg/l would extend well into these areas.

B. Supersaturation of Dissolved Oxygen indicates the presence of increased algal growth, which promotes low Dissolved Oxygen

As stated in Dr. Burkholder's attached Affidavit (Exhibit B), the supersaturation (DO greater than 100%) is an indication of algal blooms. Algae blooms, fueled by nitrogen and phosphorus pollution, are the primary driver of the Dead Zone and low DO events. This saturation indicates that this waterbody is impaired. See Exhibit B for further discussion.

C. Samples were not taken when Dissolved Oxygen would be at its lowest

It is accepted in the scientific community that DO is lowest right before sunrise. Since the Louisiana DO criterion is a minimum (see Comment 1.A.), this is when measurements should be taken to assess whether or not the DO criterion is met. See Exhibit B for further discussion.

2. Subsegments LA070601_00 (Coastal Mississippi) and LA021102_00 (Coastal Barataria) inappropriately changed from IRC 5 to IRC 5RC

The Methods and Rationale for the Integrated Report have a section that attempts to justify moving subsegments LA070601_00 and LA021102_00 from IRC 5 ("TMDL required") to IRC 5RC ("TMDL required…however, LDEQ will investigate revising criteria due to the possibility that natural conditions may be the source of the water quality criteria impairments"). As stated in Exhibit B and above it is scientifically accepted that anthropogenic nitrogen and phosphorus pollution the primary driver for low DO in Louisiana's Gulf waters (the Dead Zone). This is facilitated by physical factors, such as salinity stratification; however the cause of the low DO is not *caused* by that stratification. It is troubling to see LDEQ attempt to deny the impacts of nitrogen and phosphorus pollution on DO, despite their membership in the Hypoxia Task Force.

3. IRC 5RC and IRC 5-Alt (5-Alternative) waterbodies must be included on Louisiana's 303(d) List

Table 1 in the Methods and Rationale should be made clear that all waters in IRC 5, IRC 5RC, and IRC 5-Alt represent Louisiana's 303(d) list. As it is written, it is ambiguous as to whether LDEQ considers IRC 5RC and IRC 5-Alt as parts of the list. Since they are impaired and have no TMDL, they should be on the list.

4. IRC 5-Alt is not necessary and could be detrimental to the TMDL program

The priority watersheds outlined in Table 8 in the Methods and Rationale all are given IRC 5-Alt designation, and reference a "long-term vision" as a justification for this. It further outlines this alternative process on page 33. It is not clear how the General Alternative Plan Structure is different from a TMDL with an implementation plan. A TMDL, in practice should include assessment, loadings, and a plan to implement load reductions. It seems that the "alternative plan structure" is basically that, but removing the reduction requirements and goals and replacing them with more generic "implementation." Nowhere on p. 33-34 are reduction targets mentioned. Without a TMDL as a starting point, there is even less reasonable assurance that water bodies will achieve the loading reductions necessary to actually clean them up.

5. Waterbodies have been removed from the 305(b)/303(d) report without adequate explanation

By our count, there were over 90 waterbody/impairment combinations that were removed/moved to IRC 1 in the current report, compared to the 2014 report. These waterbody/impairment combinations are listed in Table 1.

While the Methods and Rationale state that approximately ½ of Louisiana's waters were assessed for this report, it does not state which waterbodies were. Therefore, it is impossible to discern *why* these waterbodies were removed/moved to IRC 1.

If there is a monitoring rationale with associated data supporting the removal of these waters, we request that be provided. If no adequate rationale is provided, we request that these waters be added back onto the 2016 list.

Table 1. Subsegments removed from 2016 Integrated Report

Subsegment Number	Impairment	2014 IRC
LA030201_00	Sulfates	5
	Fecal Coliform	5
LA030306_00	DDT	4a
	Methoxychlor	4a
LA030701_00	Fipronil	4a
LA 040102_00	Fecal Coliform	4a
LA040305_00	Fecal Coliform	4a
LA040603_00	Lead	5
	Fecal Coliform	4a
LA040703_00		4a
LA040904_00	Dissolved Oxygen	4a
LA040910_00	Fecal Coliform	4a
LA041101_00	Temperature	3
LA041202_00	Fecal Coliform	5
	Temperature	5
LA042101_00	Fecal Coliform	5

LA042103_00	Fecal Coliform	5
LA050101_00	Carbofuran	4a
	Fipronil	4a
LA050401_00	Fipronil	4a
LA050402_00	Chloride	5
	Sulfates	5
	Total Dissolved Solids	5
LA050601_00	Chloride	5
	Sulfates	5
	Total Dissolved Solids	5
LA050602_00	Sulfates	5
LA050603_00	Fipronil	4a
	Sulfates	5
LA050702_00	Carbofuran	4a
	Sulfates	5
	Chloride	5
	Total Dissolved Solids	5
LA050703_00	Sulfates	5
LA060206_00	Sulfates	5
LA060401_00	Carbofuran	4a
	Fipronil	4a
LA060802_00	Carbofuran	4a
	Total Dissolved Solids	4a
LA060803_00	Carbofuran	4a
LA060902_00	Carbofuran	4a
LA060903_00	Carbofuran	4a
LA060904_00	Carbofuran	4a
LA060906_00	Carbofuran	4a
LA060907_00	Carbofuran	4a
LA060910_00	Fecal Coliform	5
LA061102_00	Carbofuran	4a
	Fecal Coliform	5
LA061201_00	Fecal Coliform	5
LA070203_00	Oil and Grease	4a
	Sulfates	3
	Turbidity	3
LA080501_00	Fecal Coliform	5
LA080603_00	Sulfates	5
LA080802_00	pH	5
LA080901_00	Carbofuran	4a
	DDT	4a
	Toxaphine	4a
LA080903_00	Carbofuran	4a
	DDT	4a
LA080910_00	Turbidity	4a
LA081001_00	DDT	4a

LA081002_00	Carbofuran	4a
LA081202_00	Turbidity	4a
LA100403_00	Lead	5
LA100506_00	Temperature	5
LA100701_00	Dissolved Oxygen	5RC
	Turbidity	4a
	Fecal Coliform	5
LA100703_00	Sulfates	5
LA100801_00	Nitrate/Nitrite	3
	Dissolved Oxygen	5RC
	Phosphorus	3
LA100803_00	Fecal Coliform	5
LA101504_00	High pH	5
LA101505_00	Sulfates	4a
	Total Dissolved Solids	4a
	Turbidity	4a
LA101506_00	Lead	5
LA101603_00	High pH	5
LA101604_00	Dissolved Oxygen	4a
LA101505_00	Fecal Coliform	5
LA110401_00	Dissolved Oxygen	4a
LA110505_00	Turbidity	5
LA120205_00	pH	4a
	Turbidity	5
LA120303_00	Turbidity	5
LA120501	Chloride	5
	Total Dissolved Solids	5
LA120508_00	Dissolved Oxygen	5

6. Assimilation wetlands should be assessed.

There are several waterbodies that are labeled as "not assessed." These waters include (but may not be limited to) the following subsegments:

> LA 040604_001, LA040805_00, LA041809_00, LA060801_001, LA060805_00, LA060806_00, LA120207_00, LA120208_00

These all appear to be subsegments that are part of the "wetlands assimilation" program where treated sewage effluent is pumped into these natural wetlands. It is troubling to see that these waters are not assessed, as they have a higher potential to be impacted by a constant flow of sewage effluent. This could impair all of their designated uses. There has been concern over the efficacy of wetland assimilation, and the lack of assessment does not help this perception, much less the designated uses of the receiving wetlands.

Conclusion

Based on the arguments and evidence above we request that:

1. Place Subsegment LA120806_00 (Coastal Terrebonne) in IRC 5 for low DO, as well as for nutrients and algae
2. Place Subsegments LA070601_00 (Coastal Mississippi) and LA021102_00 (Coastal Barataria) inappropriately changed from IRC 5, not IRC 5RC, for low DO, as well as for nutrients and algae
3. Place all IRC 5RC and IRC 5-Alt waterbodies on the Louisiana 2016 303(d) impaired waters list
4. Remove the IRC 5-Alt category
5. Put all of the waters in Table 1 back on the list if no adequate justification is provided
6. Assess "wetland assimilation" areas.

Thank you for the opportunity to comment. *We look forward to your responses, including all of the issues raised in the attached affidavit from Dr. JoAnn Burkholder (Exhibit B).*

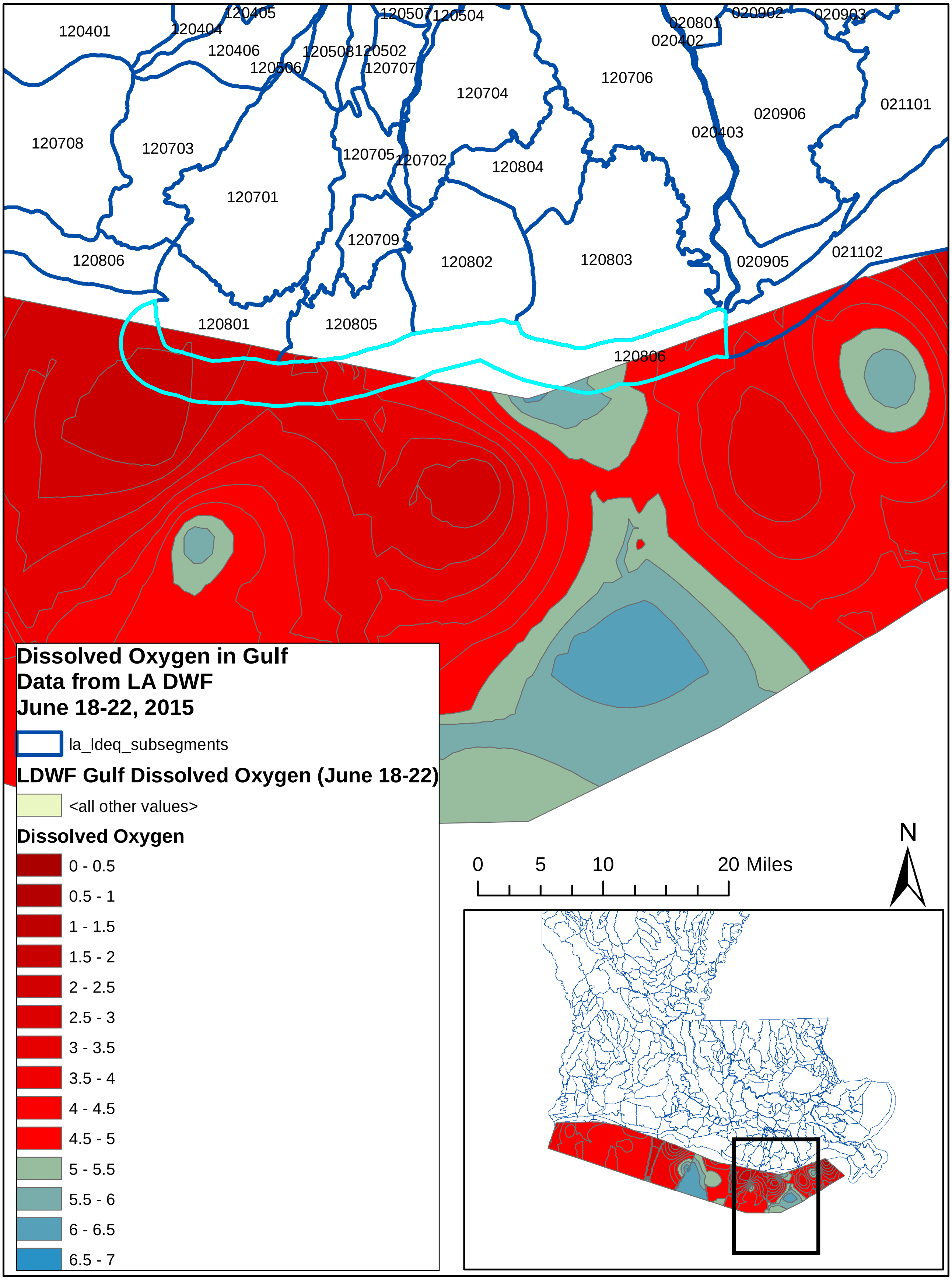
For a healthy Gulf,

Matt Rota
Senior Policy Director

CC:

Philip Crocker, EPA Region 6
Robert Cook, EPA Region 6
Klaire Freeman, EPA Region 6
Lisa Jordan, Tulane Environmental Law Clinic
May Nguyen, Tulane Environmental Law Clinic

Exhibit A



Dissolved Oxygen in Gulf
Data from LA DWF
June 18-22, 2015
la_ldeq_subsegments
LDWF Gulf Dissolved Oxygen (June 18-22)
<all other values>
Dissolved Oxygen
0 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 2.5
2.5 - 3
3 - 3.5
3.5 - 4
4 - 4.5
4.5 - 5
5 - 5.5
5.5 - 6
6 - 6.5
6.5 - 7
0 5 10 20 Miles
N
120401
120404
120405
120406
120506
120508
120502
120507
120504
120707
120704
120706
020801
020902
020903
020402
020403
020906
021101
120708
120703
120701
120705
120702
120804
120709
120802
120803
020905
021102
120806
120801
120805

Exhibit B

AFFIDAVIT OF JOANN M. BURKHOLDER, Ph.D.

BEFORE ME, the undersigned authority, personally came and appeared, JoAnn Burkholder, Ph.D., who, after being duly sworn, did depose and say:

Qualifications

1) My name is JoAnn M. Burkholder. I am an expert in water pollution assessment and water quality monitoring of freshwaters and estuaries.

2) I am a professor of aquatic science and an environmental consultant, and am working on behalf of the commenting parties in this matter.

3) An accurate copy of my curriculum vitae is attached to this Statement.

4) I have reviewed and assessed the report, *"Louisiana's 2016 Integrated Report and Section 303(d) List – Methods and Rationale"* written by the Louisiana Department of Environmental Quality (LDEQ 2016). The comments below pertain to the section, "Coastal Louisiana Dissolved Oxygen Study and Assessment," pp. 19-37 of that report. I have also read and reviewed background information referenced in those pages, as well as the following information:

Aulenbach, B.T., H.T. Buxton, W.T. Battaglin, and R.H. Coupe (2007) *Streamflow and Nutrient Fluxes of the Mississippi-Atchafalaya River Basin and Subbasins for the Period of Record through 2005.* U.S. Geological Survey Open-File Report 2007-1080. USGS, Reston, VA.

Breitburg, D.L. (2002) Effects of hypoxia and the balance between hypoxia and enrichment on coastal fishes and fisheries. *Estuaries* 25: 767-781.

Breitburg, D.L., K.A. Rose, and J.H. Cowan Jr. (1999) Linking water quality to larval survival: Predation mortality of fish larvae in an oxygen-stratified water column. *Marine Ecology Progress Series* 178: 39-54.

Breitburg, D.L., A. Adamack, K.A. Rose, S.E. Kolesar, M.B. Decker, J.E. Purcell, J.E. Keister, and J.H. Cowan Jr. (2003) The pattern and influence of low dissolved oxygen in the Patuxent River, a seasonally hypoxic estuary. *Estuaries* 26: 280-297.

Burkholder, J.M. and P.M. Glibert (2013) Eutrophication and oligotrophication, pp. 347-371. In: *Encyclopedia of Biodiversity*, 2nd edition, Volume 3, by Levin S (ed.). Academic Press, Waltham, MA.

D'Avanzo, C. and J. Kremer (1994) Diel oxygen dynamics and anoxic events in a eutrophic estuary. *Estuaries* 17: 131-139.

Day J.W., C.A.S. Hall, W.M. Kemp and A. Yanez-Arancibia (1989) *Estuarine* Ecology, 1st edition. John Wiley and Sons, New York.

Diaz, R.J. (2001) Overview of hypoxia around the world. *Journal of Environmental Quality* 30: 275-281.

Diaz, R. and R. Rosenberg (1995) Marine benthic hypoxia: A review of its ecological effects and the behavioral responses of benthic macrofauna. *Oceanography and Marine Biology: An Annual Review* 33: 245-303.

Kramer, D.L. (1987) Dissolved oxygen and fish behavior. *Environmental Biology of Fishes* 18: 81-92.

Louisiana Department of Environmental Quality (LDEQ) (2016) Louisiana's 2016 Integrated Report and Section 303(d) List – Methods and Rationale. Office of Environmental Services, Water Permits Division, LDEQ, Baton Rouge, LA.

Turner, R.E., N.N. Rabalais, and J. Dubravko (2006) Predicting summer hypoxia in the northern Gulf of Mexico – riverine N, P, and Si loading. Marine Pollution Bulletin 52: 139-148.

Turner, R.E., N.N. Rabalais, and J. Dubravko (2008) Gulf of Mexico hypoxia – alternate states and a legacy. *Environmental Science and Technology* 42: 2323-2327.

5) This statement contains my expert opinions, which I hold to a reasonable degree of scientific certainty. My opinions are based on my application of professional judgment and expertise to sufficient facts or data, consisting specifically of a review of the documents related to the LDEQ report (4, above) at issue in this matter. These are facts and data typically and reasonably relied upon by experts in my field.

6) LDEQ (2016, p.19) conducted a study from December 2014 to November 2015, ostensibly "in order to better understand depth profile [dissolved oxygen] DO levels in Louisiana waters…. In particular, the data [were] used to characterize and assess DO concentrations… in order to contribute to characterizing the depth profile observations for DO, salinity, temperature and related parameters in Louisiana territorial waters." The study involved ~quarterly sampling from ~0900 to 1340 hours (~9 am to ~1:40 pm, mostly from ~9 am to noon), over one year, of eight stations within each of three coastal subsegments, hereafter referred to as the Terrebonne (LA120806_00), the Barataria (LA021102_00), and the Mississippi (LA070601_00). The DO data were analyzed using LDEQ's routine criterion assessment procedure, wherein if more than 10% of all DO data collected over the one-year study within a given subsegment were below the criterion of 5.0 mg/L, the subsegment was evaluated, overall, as not supporting the designated use for fish and wildlife propagation.

LDEQ assessed the two coastal subsegments closest to the Mississippi River outflow, Barataria and Mississippi, as not meeting the DO criterion for the designated use, with ~37% and ~43% of data, respectively, below the criterion. LDEQ concluded that the Terrebonne subsegment was fully supporting the DO criterion, but in my expert opinion, and for the reasons explained below, LDEQ *did not* present sound scientific rationale to support delisting the Terrebonne subsegment for low DO. In addition, it is my expert opinion that, rather than assessing the other two subsegments as impaired by low DO, LDEQ wrongly asserted that "the most appropriate Integrated Report Category" for those subsegments is IRC 5RC (revise criteria)" – that is, in LDEQ's view, the DO criterion needs to be reduced to a less protective level. LDEQ's failure to evaluate the two subsegments as impaired by low DO is not science-based. LDEQ noted what has been found repeatedly in science, namely, an inverse correlation between salinity and DO in deeper coastal waters – but then the agency wrongly "decided" that salinity stratification caused the low DO concentrations. The comments below explain this overall assessment, and are followed by a recommendation of what should be done regarding the two subsegments, based on science.

<u>Summary of Opinions</u>

LDEQ did not use sound scientific rationale to support delisting the Terrebonne subsegment for low DO because the agency's sampling design greatly underestimated hypoxia/anoxia.

7) LDEQ's sampling design seriously underestimated hypoxic/anoxic conditions in the Terrebonne and the other two coastal subsegments for three reasons: (i) LDEQ sampled on only one date per season. The agency's dataset indicates that *many days of hypoxic/anoxic conditions were missed by this inadequate sampling frequency* (see pp. 5-6 below). For example, according to LDEQ (2016, Figure 7 legend), in the Terrebonne subsegment which was sampled on 14 August 2015, nearly 20% of the measurements were in violation of the 5 mg/L DO criterion. Hypoxia/anoxia are usually worst in the warmest month, August, exacerbated by high temperatures, because oxygen solubility decreases as temperatures increase (Day et al. 1985, Breitburg et al. 2003). DO violations likely occurred throughout August and perhaps longer, but measurements are available for only one day. (ii) Moreover, two subsegments were not sampled even once during August when hypoxia/anoxia is usually worst, exacerbated by high temperatures (Day et al. 1985, Breitburg et al. 2003). (iii) The information given in (i) and (ii) also underscores another fundamental, non-science-based component of LDEQ's sampling design – that is, LDEQ did not emphasize the known critical period for low DO stress to aquatic life, namely, the summer season (Day et al. 1985, Breitburg et al. 2003). Instead, equal emphasis was wrongly placed on all seasons in LDEQ's sampling design, yet the data were used to attempt to evaluate the extent to which the three subsegments were meeting their designated use.

(iii) LDEQ sampled from ~9 am until ~1:40 pm, mostly from ~9 am to noon. Yet, it is well-established in science that photosynthesis proceeding from dawn throughout the morning significantly increases the DO concentration, and that the worst (lowest) DO levels occur just before dawn (D'Avanzo and Kremer 1994, Breitburg et al. 2003). Thus, LDEQ focused on a time of day when DO concentrations would have been considerably higher than during the "pre-dawn sag." This was a fundamental, major error in LDEQ's assessment, considering that the agency used the data to attempt to evaluate the extent to which the three subsegments were meeting their designated use for fish and wildlife propagation.

Low DO stress is described as *"one of the most important consequences of high anthropogenic nutrient loadings"* because it reduces the amount and suitability of habitat for many beneficial organisms (Breitburg et al. 2003, p.280, and references therein). Low DO commonly reduces the abundance and distribution of fish and invertebrates (Kramer 1987, Diaz and Rosenberg 1995, Breitburg 2002, and references therein), with an overall impact of completely altering trophic pathways within food webs - that is, a shift in the fundamental functions and energy dynamics of the estuarine food web (Breitburg et al. 1999, Diaz 2001). Low DO at night results from high respiration of the high algal biomass in nutrient-polluted waters, leading to hypoxic or anoxic conditions (low or no DO, respectively) (Burkholder and Glibert 2013 and references therein). This "DO sag" (minimum level of DO) is usually worst (most extreme) for aquatic life just before dawn. Regarding propagation, it is well established in science that young life history stages of fish and other aquatic life are most sensitive to low DO stress (Breitburg et al. 1999, and references therein). Thus, assessment of whether the three subsegments were meeting their designated use should have focused on the critical season and, more specifically, the diel variation in DO and the occurrence of pre-dawn DO sags.

LDEQ failed to acknowledge that the major, known cause of low-DO waters along the Louisiana coast is nutrient pollution brought into Louisiana coastal waters from human sources.

8) The sampling stations of the two impaired subsegments were affected by the major sources of nutrient pollution coming into the area from the Mississippi River and other contributors of pollution in the adjacent lands of Louisiana. Much of the area west of the mouth of the Mississippi along the Louisiana coast is known to be a "dead zone" caused by nutrient pollution (see Figure 1 in these Comments). Dead zones (hypoxic/anoxic areas) are defined by federal agencies such as the U.S. Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration (NOAA) as

> ***caused by nutrient runoff from…human activities*** [emphasis added] in the watershed and are highly affected by river discharge and nitrogen [nutrient] loads. These nutrients stimulate an overgrowth of algae that sinks, decomposes, and consumes the oxygen needed to support life in the Gulf….The Gulf of Mexico dead zone is the second largest ***human-caused*** [emphasis added] hypoxic area in the world. – NOAA (2015)

In its document, "Hypoxia 101," the U.S. EPA explained that salinity stratification – which results in higher salinity in deeper waters, as LDEQ noted), *interacts* with nutrient pollution to cause the low DO problem:

> The hypoxic zone in the Gulf of Mexico…is a result of excess nutrients from the Mississippi River and seasonal stratification (layering) of waters in the Gulf.
> – U.S. EPA (https://www.epa.gov/ms-htf/hypoxia-101)

NOAA (2015) cites some of the many peer-reviewed science publications which have documented the role of nutrient pollution from the Mississippi River in causing the dead zone. NOAA conducts a major modeling effort to predict the size of the dead zone area each year. The 2015 dead zone was larger than the expected forecast because of heavy June rains which occurred throughout the Mississippi River watershed and brought even higher nutrient loads than usual into the Louisiana coastal area – during the same year when LDEQ conducted its study. The area of the dead zone shifts and changes depending on weather conditions, and the Barataria and Mississippi subsegments sampled by LDEQ would have been affected by nutrient pollution from Louisiana and the Mississippi River during 2015.

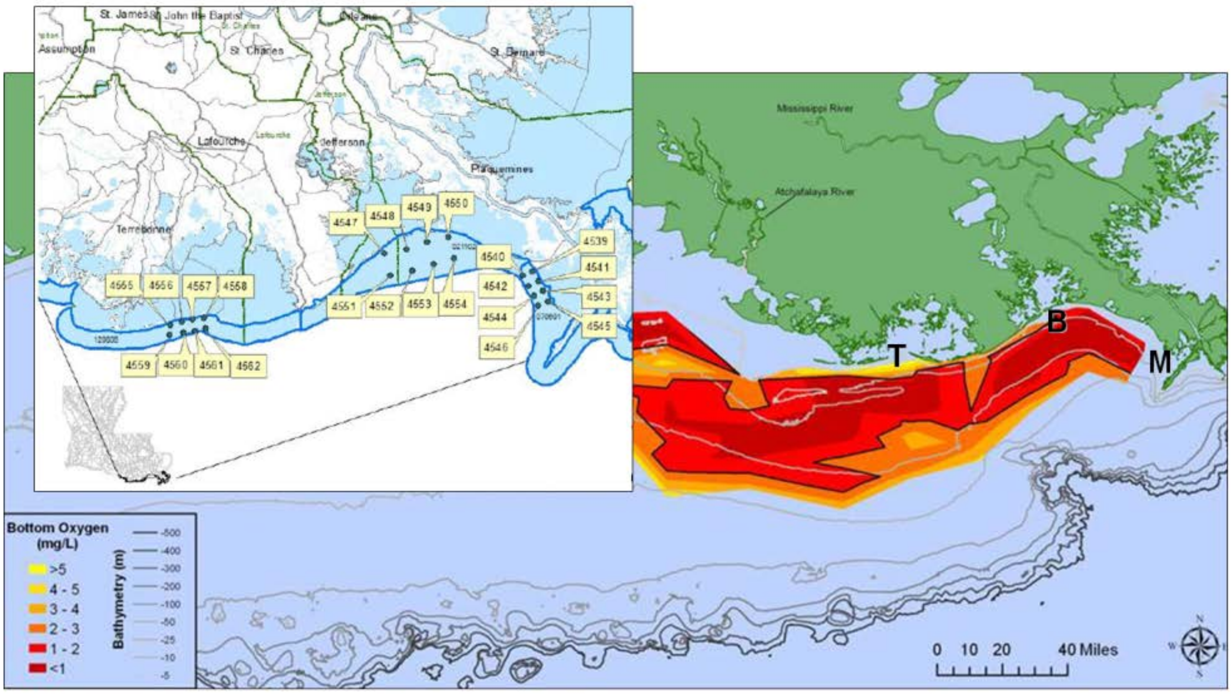


Figure 1. Smaller map: LDEQ's (2016, p.21) sampling stations in the three coastal subsegments, from west to east: Terrebonne, Barataria, and Mississippi. Larger map: the Dead Zone near the mouth of the Mississippi River as reported by NOAA (see http://www.noaanews.noaa.gov/stories2015/080415-gulf-of-mexico-dead-zone-above-average.html). This map shows the distribution of DO at depth from July 28 to August 3, 2015, west of the Mississippi River delta along the Louisiana coast, with areas in deep red having very little DO. The dead zone is known to shift or move depending on weather conditions. Note that the annual mapping of this dead zone is funded by NOAA and the U.S. EPA, according to the EPA Gulf of Mexico Program. The sampling areas within the three coastal subsegments are roughly designated T, B, and M, respectively.

*LDEQ failed to understand the scientific fact that correlation is not causality: Salinity stratification, which results in higher bottom-water salinity, coincides with low DO, but it **does not** cause low DO. Nutrient pollution causes low DO, which is exacerbated by salinity stratification.*

9) LDEQ mentioned nothing about nutrient pollution as the known major cause of low DO at depth along the Louisiana coast. Compounding that error, upon noting that increased salinity coincided with decreased DO in its dataset, LDEQ wrongly attributed the cause of low DO at depth to salinity stratification:

> As part of the sampling effort described above, salinity and temperature readings were collected along with DO. During the course of the field sampling and preliminary data analysis it was quickly recognized that salinity, in particular a sharp

salinity increase or halocline with increasing depth, *was a primary contributor* [emphasis added] for many of the low DO readings at greater depths below the surface. – LDEQ (2016, p.20)

LDEQ (2016, p.24) correctly stated that salinity was "the primary driver of the *stratification* [emphasis added] of nearshore waters" during the study, and that "salinity and density [salty water is denser than fresh water] are believed to be strong *components among the causes* [emphasis added] for low DO at greater depths when a halo/pycnocline is established." LDEQ (2016, pp. 20-21) described the Mississippi subsegment as having the most pronounced salinity stratification (referred to as haloclines) among the three subsegments, and the highest number of DO criterion failures overall. As explained above, LDEQ's 2015 study indicated that the two subsegments closest to the Mississippi River outflow had high percentages of DO criterion failures. Yet, LDEQ described only the strong haloclines that developed in those subsegments, while "overlooking" the fact that the two subsegments lie closest to the Mississippi River outflow *and the substantial nutrient pollution* contributed by it.

NOAA explained the development of low-DO water along the Louisiana coast as depicted in Figure 2 below. Note that it is the nutrient polluted-freshwater from the Mississippi River (and other land-based sources in Louisiana) that "cuts off" the saltier bottom water from contact with oxygen; and it is the nutrient pollution in the incoming freshwater that "ignites algal blooms." When the algae die, "they sink into the saltier water and decompose, depleting oxygen in the deeper water…."

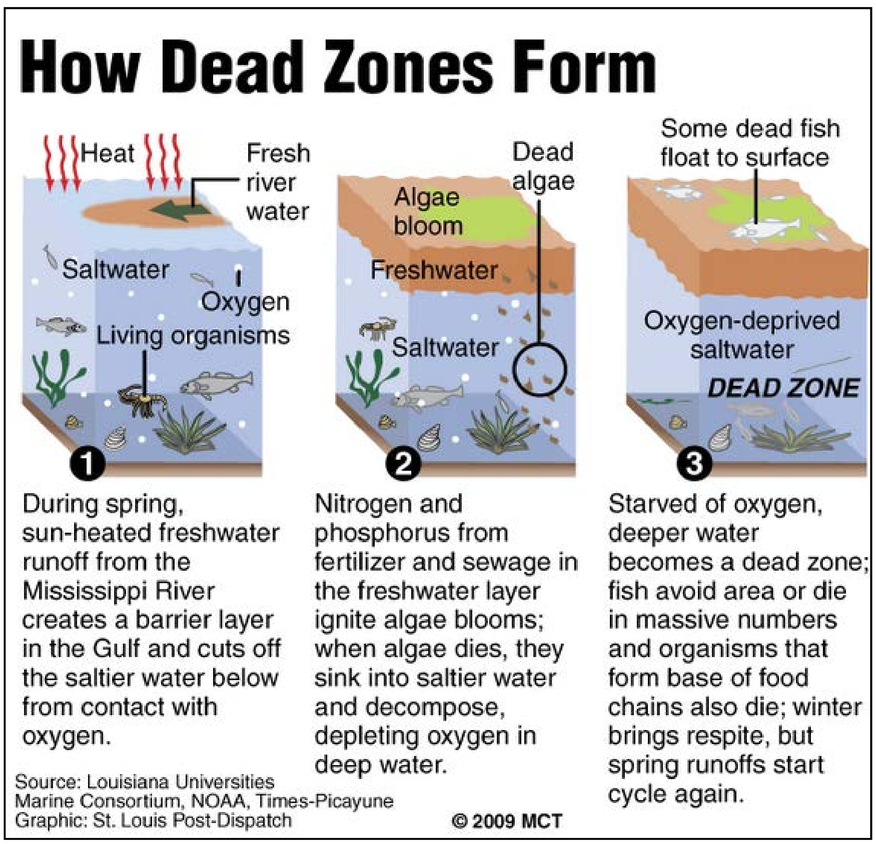


Figure 2. Diagram depicting the central role of nutrient pollution from incoming, land-based pollution in causing dead zones along the Louisiana coast each year. From the Louisiana Universities Marine Consortium and NOAA (2009).

LDEQ apparently did not notice strong evidence of algal blooms in the Mississippi and Barataria subsegments. Noxious algae are common responders to nutrient pollution, and both high nutrient pollution and noxious algal blooms are known to occur in the area.

10) As indicated in Figure 2, the nutrient pollution coming into Louisiana coastal waters is known to fuel algal blooms that lead to oxygen depletion in the deeper waters. LDEQ (2016, p.23) described DO concentrations in the Mississippi subsegment as high as 9.7 mg/L at a depth of 1 m. Actually, during the March-September growing season, DO was 10.25 mg/L (100.3% saturation) at depth, 1 meter on 24 March 2015 at one site, and 9.85 mg/L (depth, 1 meter) at another site. Such elevated DO concentrations suggest oxygen production via algal photosynthesis (Day et al. 1985). At a 1-meter depth, DO was also elevated at 8 mg/L or higher (oxygen saturation 117-124%) at three sites in the Mississippi subsegment on 18 September 2015. Algal blooms were even more apparent in the Barataria subsegment (Table 1 below). On both the spring date and the summer date sampled, DO concentrations ranged from 8.5 to 12.04 (118.1 to 156% saturation) at most sites. The data, available on only two dates throughout the growing season, suggest that algal blooms occurred throughout much of the spring and summer. The higher flow and turbidity from the Mississippi River as the water moved into the coastal area would have lessened by the time the water reached the Barataria subsegment, which would have set up more conducive conditions for algal blooms than in the Mississippi subsegment. However, many blooms likely occurred in that subsegment, as well, depending on weather conditions, and would have been entirely missed by the quarterly sampling frequency.

Table 1. Data for dissolved oxygen (DO) concentrations (milligrams per liter, mg/L) and percent saturation (%) from the Barataria subsegment, taken by LDEQ at depths ranging from 1 to 2 meters (m). Each entry represents one of the eight sites sampled in the subsegment on that date.

Date	Depth (meters)	DO (mg/L)	DO (% saturation)
4/23/2015	1 m	11	142.0
4/23/2015	1 m	10.91	140.9
4/23/2015	1 m	12.03	155.7
4/23/2015	1 m	9.75	123.2
4/23/2015	1 m	12.04	156.0
4/23/2015	1 m	11.2	145.9
7/10/2015	1 m	8.5	118.1
7/10/2015	2 m	8.62	122.8
7/10/2015	1 m	9.57	138.5
7/10/2015	2 m	9.6	140.4
7/10/2015	1.25 m	9.1	128.9
7/10/2015	2 m	8.97	127.6
7/10/2015	1 m	9.14	130.2

LDEQ failed to consider nutrient data from the Louisiana Universities Marine Consortium (LUMCON), and mentioned nothing about other nutrient data.

11) Despite a wealth of peer-reviewed science demonstrating that nutrient pollution is causing hypoxia/anoxia in Louisiana coastal waters, remarkably, LDEQ did not use any of the published scientific information to inform its sampling design or its interpretations. LUMCON and various federal agencies have tracked nutrient concentrations and loads affecting the northern Gulf of Mexico, including Louisiana coastal waters, for many years (e.g., see U.S. Geological Survey, "Streamflow and Nutrient Flux of the Mississippi-Atchafalaya River Basin and Subbasins," available by water year at http://toxics.usgs.gov/hypoxia/mississippi/flux_ests/index.html; also see background publications such as Turner et al. 2006, 2008; and Aulenbach et al. 2007).

LDEQ failed to mention nutrient pollution in its study of oxygen conditions in these coastal subsegments. LDEQ (2016, p.31) stated that IR Category 3 was used for subsegments with potential nutrient enrichment concerns, yet the agency indicated that the two subsegments with high numbers of DO criterion failures should be categorized as IRC 5RC (revise [DO] criteria).

12) Considering the above comments, the following recommendations are offered toward protecting the designated use of these three coastal subsegments for fish and wildlife propagation:

- The protective DO criterion of 5 mg/L should be retained in all three coastal subsegments.

- The major importance of nutrient pollution in causing low DO conditions in bottom waters along the Louisiana coast, exacerbated by salinity stratification, should be recognized by LDEQ rather than attributing low bottom-water DO to haloclines.

- The sampling design used by LDEQ should be substantially altered in further efforts to understand DO conditions for supporting the designated use of the coastal subsegments:
    - All three subsegments should be sampled during the critical period for low DO, that is, the spring-summer period; sampling should be conducted at least monthly during the critical period; and sampling should focus upon the worst time of day for low DO conditions, that is, the pre-dawn sag.
    - Samples for algal chlorophyll concentrations (chlorophyll *a*, corrected for pheopigments) should be taken at 1- to 2-meter depths, along with the depth profile data, to document algal blooms that substantially affect the DO regime.
    - Nutrient information is valuable in efforts to interpret the DO conditions of these subsegments. Therefore, the depth profile data (DO, salinity, temperature) should be considered together with data for nutrient (nitrogen, phosphorus) concentrations and loads in the subsegments.

JoAnn M. Burkholder

JOANN M. BURKHOLDER

SWORN TO AND ASCRIBED
BEFORE ME, THIS 29 DAY
OF MAY, 2016.

Kimberly P Pietrolungo
NOTARY PUBLIC
Commission expires
3/28/2019

KIMBERLY P. PIETROLUNGO
NOTARY
PUBLIC
WAKE COUNTY, NC