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Analysis of the Numeric Water Quality Criteria Adopted by the Ten States That Border Directly on the Mississippi River

Louisiana

November 2009

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LOUISIANA
Overview

Environmental Law Institute
September 2009

Acknowledgements

This publication is a project of the Environmental Law Institute (ELI). Funding for this project was provided by a grant from the Mississippi River Water Quality Collaborative, a group of state, regional, and national non-profit organizations working together to improve water quality in the Mississippi River basin. The findings and conclusions of this report do not, however, necessarily represent the views of the Mississippi River Water Quality Collaborative or its individual members.

The findings presented in this document are based only on what was found in final state WQS regulations as of September 1, 2008. Hence, though the existence of proposed changes to state water quality standards may be acknowledged, typically in footnotes, the contents of such potential modifications are not reflected in the various analyses contained in the report. Likewise, associated guidance documents, policy memoranda, and other state publications related to the state's WQS are not reflected in this report. As such, one limitation of this report is that it does not fully describe a given state's water quality standards program or how WQS are applied in other water quality programs.

This report was written by Bill Painter and Yen Hoang, with oversight by John Pendergrass of ELI. Mr. Painter was at the time of the research and writing of this report a Visiting Government Scholar at ELI under the Inter-governmental Personnel Act Mobility Program from the U.S. Environmental Protection Agency, where he has since returned. This report has not been reviewed by the U.S. Environmental Protection Agency and does not represent the views of the Agency, and no official endorsement should be inferred. The authors gratefully acknowledge the review and guidance provided by Judith Petersen, Albert Ettinger, Dana Wright, Jill Witkowski, Jon Devine, Jeff Grimes, Susan Heathcote, and Betsy Lawton. Drafts of the state Overviews were sent to the water quality standards staff of the respective state environmental agencies for comment. ELI received responses from Illinois, Kentucky, Louisiana, and Missouri and sought to correct all errors that were identified, but neither the Overviews nor the report represent the views of any of the states and no official endorsement by any state should be inferred. The Environmental Law Institute is responsible for the views and information contained in this publication.

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Analysis of the Numeric Water Quality Criteria Adopted by the Ten States That Border Directly on the Mississippi River

ELI Project No. 063101

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List of Acronyms

AWS	Agricultural Water Supply
BATEA (or BAT)	Best Available Treatment Economically Achievable
BOD	Biochemical Oxygen Demand
CAFO	Concentrated Animal Feeding Operation
CALM	Consolidated Assessment and Listing Methodology
CSO	Combined Sewer Overflows
CWA	Clean Water Act
DDT	Dichloro-dephenyl-trichloroethane
DO	Dissolved Oxygen
DU	Designated Use
DW	Drinking Water Standards
DWS	Drinking Water Supply
FC	Fish Consumption
GLI	Great Lakes Initiative
HHO	Human Health Organism
HHWO	Human Health: Water and Organism
IWS	Industrial Water Supply
LA	Load Allocation
MCL	Maximum Contaminant Level
MS4	Separate Sewage System
NPDES	National Pollution Discharge Elimination System
NTU	Nephelometric Turbidity Unit
PAH	Polycyclic Aromatic Hydrocarbons
PBT	Persistent, Bioaccumulative and Toxic (EPA Program)
PCB	Polychlorinated biphenyl
PWS	Public Water System
SDWA	Safe Drinking Water Act
SRF	State Revolving Fund
SSM	Single Sample Maximum
STP	Sewage Treatment Plant
TBA	Technology-Based Approach
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
TRI	Toxics Release Inventory
TSS	Total Suspended Solids
WLA	Wasteload Allocation
WQ	Water Quality
WQBA	Water Quality Based Approach
WQBEL	Water Quality Based Effluent Limits
WQC	Water Quality Criteria
WQS	Water Quality Standards

A. Introduction

This document is one of a number of state-specific reports resulting from an Environmental Law Institute (ELI) analysis of the numeric water quality criteria component of the water quality standards (WQS) of the ten states that border directly on the Mississippi River. In this report ELI compares the state numeric water quality criteria (WQC)[1] to recommended criteria and related standards[2] issued by the U.S. Environmental Protection Agency. The findings presented in the documents produced for this report are based on the most recent version of the state's final WQS regulations as of September 1, 2008. Associated guidance documents, policy memoranda and other state publications related to the state's WQS are not reflected in this report. As such, one limitation of this report is that it does not fully describe a given state's water quality standards program or how WQS are applied in other water quality programs.

This work was funded by a grant from the Mississippi River Water Quality Collaborative, a group of state, regional and national non-profit organizations working together to improve water quality in the Mississippi River basin.

B. Summary of Findings

The water quality criteria (WQC) specified in Louisiana's water quality standards (WQS) regulations[3] present a mixed picture when compared to the criteria published[4] by EPA in terms of 1) pollutant /use combinations[5] covered, 2) the degree to which all key elements of criteria are clearly articulated, and 3) level of protection likely afforded to applicable designated uses.

Louisiana has adopted numeric water quality criteria for a large array of pollutants/use combinations. There are, however, a number of instances in which the state has not established

[1] The terms "water quality criteria," "WQC," and "criteria" are used interchangeably in this report. Water quality criteria are closely associated with another key element of water quality standards established under state law and the federal Clean Water Act. Criteria describe waterbody conditions, primarily pollutant levels, associated with full support of one or more of the designated uses (e.g., aquatic life, fish consumption, water contact recreation and drinking water supply) assigned to specific waters by a state's water quality standards regulations.

[2] The recommended EPA criteria are water quality criteria (WQC) issued by that agency under authority of the federal Clean Water Act. The "recommended EPA criteria" referred to in this report are water quality criteria (WQC) issued as guidance to states, territories, and authorized tribes by the EPA under authority of the federal Clean Water Act. The "related EPA standards" are federal regulatory requirements applicable to finished (post treatment) drinking water that is delivered to homes and businesses by a public drinking water system. These standards are established by EPA under authority of the Safe Drinking Water Act (SDWA).

[3] Title 33 Louisiana Code: Environmental Quality: Part IX. Water Quality: Subpart 1. Water Pollution Control, Chapter 11 Surface Water Quality Standards.

[4] Throughout this report, the water quality criteria (WQC) recommended by EPA under the Clean Water Act will be referred to as the EPA's "issued" or "published" criteria, interchangeably. Unlike Primary Drinking Water Standards promulgated by the Agency according to the federal Safe Drinking Water Act, EPA WQC are not regulatory requirements. Terms like "established," "promulgated," and "set" are not used because EPA criteria are guidance, issued to help the states adopt their own water quality criteria in their water quality standards (WQS) regulations.

[5] As used in this report, "pollutant/use combination" refers to designated use and a particular pollutant or other water quality parameter. Often states have just one WQC for a given pollutant and use; however, in the case of aquatic life criteria, more than one WQC per pollutant/use combination is common. This is usually due to: 1) having both acute and chronic criteria; 2) breaking aquatic life down into a number of sub-categories (e.g., cold and warm water habitat); 3) establishment of different criteria for different ecoregions within the state; and/or 4) setting waterbody-specific WQC.

criteria for pollutant/use combinations for which EPA has issued WQC under the authority of Section 304(a) of the CWA. For example, the state is missing[6] aquatic life (Fish and Wildlife Propagation) criteria for a number of traditional pollutants[7] for which EPA has issued such WQC, including the nutrients nitrogen and phosphorous, as well as for chlorophyll a, an indicator of algal density. Unnaturally high density of certain forms of algae resulting from excessive levels of nutrients has adverse effects on aquatic life, as well as use of impacted waterbodies for public water supply and water-based recreation. In addition, except for turbidity criteria and guidance values for certain waters, the state lacks WQC for suspended and bed sediments, which also can interfere with a number of uses.

As for toxic pollutants, Louisiana lacks aquatic life criteria for freshwater and marine waters for a number of toxic pollutants,[8] though it has "extra"[9]criteria for a somewhat larger set of pollutants. Louisiana has no criteria that address possible adverse effects of ingestion of toxic substances resulting from consumption of fish, shellfish, and other aquatic species alone, whereas EPA has issued such WQC for 106 toxic pollutants. The federal EPA refers to this set of WQC as Human Health: Organisms (HHO) criteria. Likewise, the states lacks WQC addressing the health risk associated with intake of toxic substances resulting from human consumption of both 1) fish, shellfish, and other aquatic species plus 2) drinking water from a given waterbody, while EPA has issued WQC for 113 toxic substances related to the combination of these two waterbody uses. (EPA calls these Human Health: Water and Organisms (HHWO) criteria.) Among those pollutants with missing these two specific types of WQC are a number of known or suspected carcinogens, bioaccumulators, and endocrine disruptors.

On the other hand, Louisiana does have two sets of WQC that are closely related to EPA's Human Health: Organisms and Human Health: Water and Organisms water quality criteria. First, the state has adopted WQC for 39 toxic chemicals aimed at people who are using a waterbody as 1) a supplier of fish and other aquatic foodstuffs, and 2) a place for water-contact recreation, which it calls Human Health: Non-Drinking Water Supply criteria. And, the state has another set of WQC for 54 toxics aimed at people who are using a waterbody as 1) a supplier of fish and other aquatic foodstuffs, 2) a place for water contact recreation, and 3) a source of drinking water, which it calls Human Health: Drinking Water Supply criteria. EPA has not issued any WQC for toxics for these two combinations of uses, nevertheless, because the amount

[6] For the purposes of this review, "missing" criteria are those pollutant/use combinations for which the state has not officially adopted WQC, whereas EPA has published recommended WQC of the type specified.

[7] For purposes of this ELI report, "traditional pollutant/parameter" refers to a number of pollutants and water quality parameters that were recognized as significant contributors to and indicators of degradation of the condition of surface water well before passage of the Clean Water Act in 1972. As used in this study, "traditional pollutant" includes those pollutants/parameters referred to as "conventional" in the CWA and EPA regulations and guidance, which includes: biochemical oxygen demand (BOD), dissolved oxygen (DO), pH, total suspended solids (TSS), bacteria and other pathogens, and temperature. Also considered "traditional" in this document are several other non-toxic pollutants and parameters including alkalinity, chloride, chlorophyll a, color, dissolved solids, hydrogen sulfide, (total) nitrogen, oil and grease, total phosphorus, and turbidity, which are sometimes called "non-conventional" or "non-priority" in the EPA literature. Also, one "non-priority" toxic chemical, ammonia, is discussed under the heading "traditional pollutants/parameters."

[8] In this report, "toxic pollutant" includes not only EPA's "priority toxic pollutants" but also: a) all those toxics that EPA calls, for CWA purposes, "non-priority pollutant," and, b) all toxic chemicals not falling in either of these categories (the one exception is ammonia – see footnote 3).

[9] For the purposes of this report, "extra" criteria are those pollutant/use pairs for which the state has officially adopted criteria, but for which EPA has not issued corresponding criteria.

of a toxic compound likely to be taken in during water contact recreation should be small, in relation to that resulting from fish consumption or drinking water, it seems reasonable to 1) treat Louisiana's Human Health: Non-Drinking Water Supply criteria as reasonably comparable to the federal EPA's Human Health: Organisms (HHO) criteria, and 2) Louisiana's Human Health: Drinking Water Supply criteria as reasonably comparable to EPA's Human Health: Water and Organisms (HHWO) criteria.

Using these analogies, whereas Louisiana has Human Health: a Non-Drinking Water Supply criterion for 39 toxic substances, EPA has Human Health: Organisms criteria for 106 toxics. And, while there are EPA Human Health; Water and Organisms WQC for 113 toxics, there are just 54 pollutants for which Louisiana has established Human Health: Drinking Water Supply WQC. On the other hand, Louisiana has Non-Drinking Water Supply criteria for four toxic substances for which there are no EPA HHO. Likewise, Louisiana has Drinking Water Supply criteria for thirteen pollutants for which there are no EPA HHWO criteria.

The state's WQC for traditional pollutants generally have criterion-concentrations[10] that are equal or close to the criterion-concentrations of corresponding EPA WQC and those of nearby states studied in this report. The majority of Louisiana's aquatic life (freshwater and marine) criteria for toxic chemicals have criterion-concentrations that are identical to those in corresponding EPA criteria, while a few criteria have higher or lower criterion-concentrations.

As for criteria aimed at the protection of human health from adverse effects of toxic substances, the majority of the state's WQC have criterion-concentrations that are lower than that of corresponding EPA WQC. For human health protection, Louisiana has recently adopted revised "human health protection: drinking water supply" criteria for seven pollutants and revised "human health protection: non-drinking water supply" criteria for five pollutants. Most of these revised human-health criteria have criterion-concentrations that are lower than EPA's.

Some of the state's numeric WQC for traditional pollutants have clearly-stated criterion-durations[11] while others do not. For example, one of the state's Fish and Wildlife Propagation WQC reads, "Dissolved oxygen concentrations in estuarine waters shall not be less than 4.0 mg/L at any time." This wording clearly indicates a criterion-duration of an instant. But, there are other WQC for traditionals that simply refer to maximum (or minimum for dissolved oxygen) concentrations, without making any mention of a duration or averaging period. In such cases, a criterion-duration of an instant is assumed. The state also has chronic WQC for several pollutants that, in essence, have open ended criterion-durations, as they call for averaging of all available data, regardless of the span of time over which data happens to have been collected on a given waterbody.

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[10] According to EPA guidance, numeric water quality criteria (WQC) consist of three components: 1) a criterion-magnitude, 2) a criterion-duration, and 3) a criterion-frequency. The first of these – criterion-magnitude is usually expressed as a concentration; hence, the frequent use of "criterion-concentration" in this report. For some key water quality parameters, such as temperature and pH, quantity is not expressed as a concentration, so EPA employs the broader term "criterion-magnitude."

[11] According terminology employed in some EPA guidance, the criterion-duration portion of a numeric WQC specifies the length of an "excursion" – the time period over which waterbody concentration of a pollutant is higher (or in the case of dissolved oxygen, lower) than the criterion-magnitude. For instance, EPA's chronic aquatic life WQC for toxic chemicals have a criterion-duration of four days, which results in their being expressed as four-day average concentrations. The occurrence of one or more excursion (e.g., a four-day period in which the instream concentration of cyanide was higher than the criterion-concentration of 5.2 µg/L) would not necessarily represent failure to meet WQC. Only when the rate at which excursions occur is higher than that specified by the criterion-frequency has an actual exceedance of a water quality criterion occurred.

None of Louisiana's WQC for toxic pollutants has clearly-articulated criterion-durations, though durations of one hour and four days/96 hours for acute and chronic aquatic life criteria, respectively could be inferred indirectly from references in the state's WQS regulations to EPA's aquatic life criteria for toxic chemicals. Though Louisiana's WQS regulations also make direct reference to EPA's human health WQC and the methods used to derive them, and also use the same names for its criteria (Human Health: Organisms and Human Health: Water and Organisms), it is difficult to infer a criterion-duration for these two sets of state criteria because the EPA literature regarding the criterion-duration for its human health criteria for toxics is inconsistent, sometimes giving the impression that the duration for these categories of criteria is an instant, while at other times indicating a duration as long as 70 years. In the absence of clear guidance from either the state's WQS regulations or the federal EPA's literature, a criterion-duration of an instant is assumed for purposes of this report.

Of all the types of WQC specified in Louisiana's WQS regulations, only the criteria for fecal coliform bacteria applicable to primary and secondary contact recreation, drinking water supply, and oyster propagation have an explicitly-stated criterion-frequency.[12] None of the other WQC for traditional pollutants or any of the criteria for toxic substances contains reference to a criterion-frequency. As for toxic chemicals, none of the state's criteria make direct or indirect mention of a criterion-frequency. However, since language in the regulations links the state's WQC for toxics to EPA's, use of EPA's recommended frequency of no more than one excursion[13] in any three year period is assumed in this report, with regard to Louisiana's aquatic life criteria for toxics. On the other hand, because EPA makes no mention of a criterion-frequency for its human health WQC for toxics, a criterion-frequency of zero is assumed for Louisiana's human health-related criteria for toxic substances.

As for the level of protection provided by a state WQC for a given pollutant/use combination in comparison to that of EPA (or another state), this cannot be done with any degree of confidence unless all three elements of both WQC are clearly articulated. And, even when the criterion-concentration, criterion-magnitude, and criterion-frequency of each of the two WQC being compared are precisely stated, their comparative degree of protectivity can only be determined, simply by looking at the two WQC and nothing else, with certain combinations of relative criterion-concentration, concentration-duration, and combination-frequency. For instance, if a state and a comparable (same pollutant and same designated use) EPA criterion both have the same criterion-concentration, same criterion-duration, and the same criterion-frequency, they would provide equal levels of protection. If, however, the criterion-concentration of one of the two WQC were lower than the other, and the criterion-duration and criterion-frequency remained identical, then that WQC would provide the higher degree of protection. Likewise, if the criterion-concentrations are the same, the criterion-durations are identical, but one of the WQC has a lower acceptable criterion-frequency, then that criterion with the lower frequency would provide more protection. Also providing a higher level of protection would be a

[12] In EPA WQS terminology, the criterion-frequency specifies the maximum rate at which "excursions" (see footnote 11) can occur and the waterbody of concern can still fully support the designated use to which the criterion applies. For instance, EPA guidance specifies a criterion-frequency of once in three years for both its acute and chronic WQC for toxic chemicals aimed at aquatic life protection. This means that only if two or more excursions occur during any three year period has there actually been an exceedance of the WQC in question. For example, only if the four-day average concentration of cyanide in a lake were higher than 5.2 µg/L more than once in three years would there have been failure to meet the EPA chronic aquatic life WQC.

[13] As used in this report, and in some EPA guidance documents, an "excursion" is any period equal in length to the criterion-duration of a WQC when the average waterbody concentration is higher than the criterion-concentration.

WQC with a shorter criterion-duration than a comparable WQC that had the same criterion-concentration and criterion-frequency. Appendix C provides a set of tables that list all possible combinations, in relative terms, of criterion-concentrations, criterion-durations, and criterion-frequencies, indicating which represent higher, lower, and identical levels of protection.

Unfortunately, the relevance of the tables in Appendix C to Louisiana's WQC is significantly limited by the fact that, though a majority of the state's criteria have a specified criterion-duration, the state's WQS regulations make no mention of a criterion-frequency for any of its water quality criteria. Further complicating comparison of the level of protection afforded to applicable designated uses by a state WQC is the fact that most of EPA's criteria for traditional pollutants lack a clearly-articulated criterion-duration and criterion-frequency.

As to the degree of protection provided by Louisiana's WQC in relation to corresponding EPA criteria, a simple comparison of the criterion-concentration in a given state criterion to that of EPA's is not necessarily a reliable indicator of relative protectiveness. Attention also must be paid to the criterion-duration and criterion-frequency in each of criteria being compared. If the criterion-duration and criterion-frequencies of the state and EPA are identical, then the WQC with the lower criterion-concentration will indeed provide more protection to the use to which the criteria apply, while a higher concentration would be indicative of less protection. For instance, if one assumes, as is done in this report, that Louisiana's Fish and Wildlife (Fresh Water and Marine Water) WQC for toxics have the same criterion-duration[14] (acute criterion-duration of one hour; chronic criterion-duration of 96 hours) and criterion-frequency (maximum of one excursion[15] in three years) as do EPA's criteria for toxics for aquatic life, then, for example, those six Louisiana acute freshwater aquatic life criteria for toxics having the same criterion-concentration as the corresponding EPA WQC would provide the same protection as would EPA's WQC, while those five with criterion-concentrations lower than EPA's would be more protective, and those seven Louisiana WQC with higher criterion-concentrations would provide less protection.

Other combinations of criterion-durations and criterion-frequencies in the WQC under consideration can also be taken as grounds to believe that one criterion is more protective than another. For example, if a state criterion had a shorter criterion-duration and lower criterion-frequency than that of the corresponding EPA criterion, then if the state's criterion-concentration were equal to or lower than that of the EPA criterion, it would clearly provide a higher level of protection than EPA's. This would be the case, for example, for six of the state's acute Fresh Water Aquatic Life WQC if, instead of employing the same criterion-duration (one hour, and same criterion-frequency) maximum of one excursion in any three year period, as those of EPA's aquatic life criteria, one assumed a criterion-duration of an instant and a criterion-frequency of zero. However, for those seven Louisiana acute Fresh Water Aquatic Life WQC with a criterion-concentration higher than EPA's, if criterion-duration were an instant and the criterion-frequency were zero, it would be difficult to know ascertain the relative protection provided by the two criteria, based just on looking at the two WQC. Without obtaining or collecting additional toxicity data, there would be no way to know whether the less protective effect of the state's higher criterion-concentration would be outweighed by the state's shorter criterion-duration and lower criterion-frequency. Several other combinations of relative concentrations, durations, and frequencies between WQC also present a complex situation. See Appendix C for a chart listing

[14] Id. at 11

[15] As used in this report, and in some EPA guidance documents, an "excursion" is any period equal in length to the criterion-duration of a WQC when the average waterbody concentration is higher than the criterion-concentration.

all the possible combinations of the three components of a properly-articulated numeric WQC, and what they mean in terms of comparative levels of protection.

Needless to say, ascertaining the relative degree of protection provided by one WQC verses another based solely on the two criteria themselves is rendered more difficult if the concentration, duration, and/or frequency of either of the WQC are not well articulated. For example, Louisiana has a dissolved oxygen (DO) criterion with the same criterion-concentration as EPA's only criterion for this parameter applicable to freshwater aquatic life: 5.0 mg/L. Both state and EPA's WQC simply describe 5.0 mg/L as a minimum concentration, without specifying whether this is an instantaneous minimum concentration or should be dealt with as an average over a certain period of time. In this report, when criteria are worded like these criteria, then a criterion-duration of an instant is assumed. Given that neither Louisiana's or EPA's criteria make mention of a criterion-frequency, this report assumes they both have a criterion-frequency of zero. Based on these assumptions, then Louisiana's and EPA's criteria would be equally protective. But, if one assumed that EPA's WQC for DO had a criterion-duration of a day (24 hours) while retaining the assumption of an instantaneous criterion-duration for the state WQC, then the state's WQC would be the more protective of the two, given equal criterion-concentrations, lower state criterion-durations, and identical criterion-frequencies.

Further complicating this picture, with regard to aquatic life WQC, there could be state-specific, watershed-specific, or even waterbody-specific reasons (differences in water column chemistry, temperature, stream flow patterns, resident species of aquatic life) that a state criterion can have a criterion-concentration higher or lower than that for the corresponding EPA criterion and still provide aquatic life protection equal to that for which the EPA WQC was designed. Louisiana has in fact, made adjustments to EPA's aquatic life WQC for cadmium and copper of its aquatic life WQC, to account for the fact that the EPA WQC were based in part on effects of these two metals to cold water fish, none of which are native to Louisiana. This resulted in state WQC with higher criterion-concentrations than the concentrations of corresponding EPA WQC. Therefore, even though the state's WQC have higher criterion-concentrations, while the criterion-duration and criterion-frequency are (we assume) identical, this does not necessarily mean the state's WQC provide insufficient protection to the species native to Louisiana's waters; rather, in theory, the level of protection provided by the state's WQC should be essentially the same as the level for which the EPA WQC were designed. Site-specific conditions could have resulted in EPA's WQC providing a higher level of protection than that for which EPA designed it. The effect of the state's higher criterion-concentration would be to bring the level of protection back down to that intended by EPA.

Turning from aquatic life to human health, safe levels of pollutants tend to vary less from waterbody to waterbody. The most obvious reason is that, unlike aquatic life WQC, human health criteria address impacts on just one species, regardless of the location of the waterbody to which the WQC apply. The most common reason for need for variation in human health criteria from one locale to another is differences in patterns of human use. For example, regarding drinking water use, persons in hotter climates tend to consume more water, on average, than those in cooler areas. Also, the amount of fish and other aquatic life from local waters that are caught and eaten by people can differ by an order of magnitude from place to place and/or within subpopulations of humans. And, of course, patterns of swimming and other water contact recreation can change considerably depending on difference in the climate in which one waterbody verses another is located, along with the type of waterbody (river, lake, ocean beach).

In calculating its fish consumption-related WQC (Human Health: Organisms and Human Health: Water and Organisms), the state does use an assumed fish consumption rate (20g/day) that is slightly higher than that used by EPA in calculating its WQC (17.5 g), based on studies of fish consumption patterns in Louisiana. However, Louisiana's WQS regulations give no indication of modification of criterion-concentrations for WQC related to fish consumption to account for higher rates of human fish consumption from some waterbodies to another within Louisiana. Perhaps there are no such differences within Louisiana, though it would seem probable that subsistence patterns of fish consumption would be more likely in the southern part of the state. If there are some areas where subsistence-fishing is more common than others, then persons in the former areas would be getting a lower level of protection than the latter areas, all other factors being equal. Conversely, persons taking fish from a given waterbody at a rate lower than that assumed by the state would be provided a higher level of protection than that for which the state WQC was designed.

Returning briefly to the effects of unaddressed or imprecisely articulated criterion-durations and criterion-frequencies, in addition to making comparison of levels of protection afforded relevant uses difficult, if not impossible, such ambiguities can pose challenges to the implementation of CWA programs driven by WQS: 303(d) and 305(b) reporting on the condition of a state's waters, total maximum daily loads (TMDLs), and water-quality based effluent limits in NPDES permits. For instance, if a TMDL were being developed because of exceedences of one of Louisiana's Human Health: Non-Drinking Water Supply criteria WQC, the absence of a clearly-articulated criterion-duration for this category of WQC would create a quandary. What should the time-interval for the maximum loading set forth in the TMDL be? If one assumes, as has been done in this report, a default criterion-duration of an instant in such circumstances, then it would seem logical to express the TMDL as a maximum load over a very short interval, even just a second. On the other hand, if the criterion-duration for the state's Human Health: Organisms WQC were twelve months, then setting a maximum twelve month total load would seem appropriate.[16]

C. "Traditional" Pollutants/Parameters[17]

1) Coverage

a) Aquatic Life / "Fish and Wildlife Propagation"[18]

[16] In *Friends of the Earth v EPA*, 446 F.3d.145 (2006) the federal D.C. Circuit Court ruled that because of the specific reference to "daily" in the portion of Section 303(d) of the CWA that established the Total Maximum Daily Load program, all TMDLs should include, at least, a maximum daily load. Despite this ruling, maximum loads over other time spans would also be needed, in order for the TMDL to consistent with relevant WQC, when such criteria have criterion-durations other than 24 hours.

[17] For purposes of this ELI report, "traditional pollutant/parameter" refers to a number of pollutants and water quality parameters that were recognized as significant contributors to and indicators of degradation of the condition of surface water well before passage of the Clean Water Act in 1972. As used in this study, "traditional pollutant" includes those pollutants/parameters referred to as "conventional" in the CWA and EPA regulations and guidance, which includes: biochemical oxygen demand (BOD), dissolved oxygen (DO), pH, total suspended solids (TSS), bacteria and other pathogens, and temperature. Also considered "traditional" in this document are several other non-toxic pollutants and parameters including alkalinity, chloride, chlorophyll a, color, dissolved solids, hydrogen sulfide, (total) nitrogen, oil and grease, total phosphorus, and turbidity, which are sometimes called "non-conventional" or "non-priority" in the EPA literature. Also, one "non-priority" toxic chemical, ammonia, is discussed under the heading "traditional pollutants/parameters."

Louisiana lacks an acute and/or chronic WQC for a number of the traditional pollutants for which EPA has published criteria. Among those currently missing[19] are several criteria corresponding to publish EPA criteria intended to address ecological effects of hyper-eutrophication due to excess loadings of nutrients chlorophyll a, total phosphorous, and total nitrogen. The excess algal growth resulting from hyper-eutrophication also can have adverse impacts on water-based recreational uses and drinking water supply use, in addition to aquatic life uses.

On the other hand, for freshwaters, Louisiana has several "extra"[20] criteria. For example, the state has an acute criterion for temperature, as well as chronic criteria for four parameters for which EPA has not issued chronic criteria. Also, the state has a number of criteria applicable to estuarine, coastal, and marine waters for which there are not corresponding EPA criteria (Appendix A, Table 1).

b) Human Health: Consumption of Fish and Other Aquatic Organisms/ "Oyster Propagation"

Like EPA, Louisiana has a chronic fecal coliform criterion applicable to designated shellfishing areas (Louisiana calls them Oyster Propagation areas).

In addition, the state has a "criterion" expressed as: "Not more than ten percent of the samples shall exceed an MPN of 43 per 100 mL."[21] EPA does not have a comparable criterion for this use.

c) Human Health: Drinking Water Supply / "Drinking Water Supply"

Louisiana lacks criteria applicable to drinking water supply use for seven of the eight traditional parameters for which EPA has promulgated somewhat related standards under the federal Safe Drinking Water Act.[22] The state does have a WQC for fecal coliform bacteria,

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[18] Throughout this document, generic names (e.g., "aquatic life," "human health: drinking water supply," and "human health: water contact recreation") are used in reference to certain categories of uses. When a state uses different wording to refer to one of the generic uses, the name the state employs is listed in quotation marks, following the generic use.

[19] For the purposes of this review, "missing" criteria are those pollutant/use combinations for which the state has not officially adopted WQC, whereas EPA has published recommended WQC of the type specified.

[20] For the purposes of this report, "extra" criteria are those pollutant/use pairs for which the state has officially adopted criteria, but for which EPA has not issued corresponding criteria.

[21] Technically, this is not a water quality criterion, as it does not stipulate conditions in a waterbody; rather, it is an assessment methodology, in that it describes the characteristics of a set of samples taken from a waterbody. A true WQC would describe desired conditions in the waterbody itself, and be expressed in a manner similar to the following: "The density of ____ bacteria in surface waters shall be higher than ___ no more than ___% of the time." In this report, it is assumed that the individual samples collected from a waterbody would be taken in a randomized manner, which should make the set of samples representative of the actual conditions in the waterbody during the month in which monitoring took place. In this case, this results in an implicit criterion of "bacterial density shall be above 43 MPN/100 ml no more than ten percent of the time."

[22] Unlike the water quality criteria that it issues for CWA purposes, the drinking water standards that EPA promulgates, via formal rulemaking, under authority of the Safe Drinking Water Act are regulatory requirements, not just recommendations. EPA lacks actual drinking water supply criteria for traditional pollutants – specification of the levels of contaminants in surface waters being used as a raw water supply by public drinking water systems. The only EPA standards aimed at ensuring safe levels of contaminants in drinking water apply to "finished" water –

whereas EPA's drinking water standard is for total coliform bacteria. However, with the exception of total coliform bacteria, the EPA standards for these eight pollutants/parameters are "secondary" drinking water standards (related to taste, odor, and appearance of drinking water), rather than "primary" drinking water standards (related to health) (Appendix A, Table 2).

Louisiana also lacks WQC for the nutrients phosphorous and nitrogen, excess levels of which can lead to unnatural blooms of aquatic algae. High levels of algae in the raw water supply used by a public drinking water system can result in unpleasant taste and odor in finished drinking water, unless special care is taken in the drinking water treatment process. Such extra treatment efforts can, in turn, lead to increased costs to a drinking water utility and its customers.

d) Human Health: Water-Contact Recreation / "Primary Contact Recreation" and "Secondary Contact Recreation

While it has fecal coliform criteria for acute exposure from water-based recreation, Louisiana has no chronic criteria for this indicator of potential pathogens (Appendix A, Table 3). Louisiana has adopted no criteria for the bacterial indicators *E. coli* and Enterococci that are applicable to either fresh or coastal waters, though EPA issued nationally-recommended criteria for these two pathogen indicators over two decades ago (1986). EPA has recently promulgated Enterococci criteria applicable to Louisiana's coastal and marine waters, under the authority of the "BEACH Act." Though these WQC do not appear in the state's WQS regulations, they do have force of law with regard to implementation of the federal Clean Water Act.

The state also lacks WQC for the nutrients phosphorous and nitrogen, excess levels of which can lead to unnatural blooms of aquatic algae. Such blooms can form mats on the water surface which can interfere with a variety of water-based recreational activities.

e) Agricultural Water Supply / "Agriculture"

EPA has issued (in 1976) agriculture water supply criteria for boron/borates, while Louisiana has not. The state does have WQC for chlorides, pH, sulfates, and turbidity (NTU) that apply to all waters, regardless of designated use(s).

f) Industrial Water Supply

EPA has issued industrial water supply criteria for calcium carbonate. Louisiana does not have a specific industrial water supply designated use in its WQS regulations

2) *Criterion-Concentrations[23], Compared to EPA's*

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that which results from raw source water being passed through a treatment system designed to remove contaminants to the maximum degree practicable.

[23] According to EPA guidance, numeric water quality criteria (WQC) consist of three components: 1) a criterion-magnitude, 2) a criterion-duration, and 3) a criterion-frequency. The first of these, criterion-magnitude, is usually expressed as a concentration; hence, the frequent use of "criterion-concentration" in this report. For some key water quality parameters, such as temperature and pH, quantity is not expressed as a concentration, so EPA employs the broader term "criterion-magnitude."

a) Aquatic Life / "Fish and Wildlife Propagation"

Most of Louisiana's aquatic life criteria for traditional pollutants have criteria-concentrations identical, or very close, to those published by EPA, and within the same range as similar WQC adopted by the other nine states covered by this Environmental Law Institute report. Some differences are worth mentioning.

For example, the state has a number of waters with site-specific dissolved oxygen (DO) criteria with criterion-concentrations between 2.0 and 3.5 mg/L, a range that is considerably lower than EPA's generic national aquatic life criteria of 5.0 mg/L which were published in the Red Book in 1976. Given that a number of the waters in the state are bayous, swamps and marshes, it is quite possible that some of these waters would have natural DO levels that correspond to the state's waterbody-specific criteria.

Louisiana has not adopted any criteria for chlorides specific to aquatic life. EPA's acute aquatic life criterion for chloride is a one hour average of 860 mg/L. Louisiana's chronic chloride criterion for unclassified waters[24] has a criterion-concentration of 250 mg/L, which is slightly higher than EPA's chronic criterion-concentration for aquatic life. There is, however, a difference between EPA's and the state's criterion-durations[25] (see discussion under "Criterion-Duration: Aquatic Life" in Subsection C(3)(a) below). The state has adopted waterbody-specific chronic WQC for chloride for a number of waters (Table 3 in the Louisiana WQS regulations); for these, the criterion-concentrations range between 10 mg/L to over 5,000 mg/L.

Louisiana's chronic criterion for unclassified waters for total dissolved solids (TDS) has a criterion-concentration of 500 mg/L. The state's waterbody-specific chronic TDS criteria (specified in Table 3 of the Louisiana WQS regulations) have criterion-concentrations ranging from 55 mg/L to 10,000 mg/L. EPA has no aquatic life criteria for TDS.

Louisiana's chronic criterion for sulfates applicable to unclassified waters has a criterion-concentration of 250 mg/L. Site-specific sulfate criteria (specified in Table 3 of the Louisiana WQS regulations) have criterion-concentrations ranging from 5 mg/L to 750 mg/L. EPA has no aquatic life criteria for sulfates.

EPA has adopted ecoregion-specific and waterbody type-specific WQC for the four parameters covered by the Agency's "nutrient criteria"[26] to two ecoregions present in Louisiana, Ecoregion IX (Southeastern Forested Plains and Hills) and Ecoregion X (Texas-Louisiana Coastal and Mississippi Alluvial Plains). The state has not adopted nor proposed criteria for total N, total P, chlorophyll a, or turbidity based on such EPA standards or other sources; hence, no comparison of criterion-concentrations is possible.

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[24] "Criteria for unclassified waters," for the purposes of this review, are criteria that apply to a waterbody even though the state's WQS regulations do not assign specific designated uses to the water.

[25] According terminology employed in some EPA guidance, the criterion-duration portion of a numeric WQC specifies the length of an "excursion" – the time period over which waterbody concentration of a pollutant is higher (or in the case of dissolved oxygen, lower) than the criterion-magnitude. For instance, EPA's chronic aquatic life WQC for toxic chemicals have a criterion-duration of four days, which results in their being expressed as 4 day average concentrations. The occurrence of one or more excursion (e.g., a four day period in which the instream concentration, for example, of cyanide was higher than the criterion-concentration of 5.2 µg/L) would not necessarily represent failure to meet WQC. Only when the rate at which excursions occur is higher than that specified by the criterion-frequency has an actual exceedance of a water quality criterion occurred.

[26] EPA's package of nutrient criteria includes not only WQC for nitrogen and phosphorous, but also for turbidity and chlorophyll a.

b) Human Health: Consumption of Fish and Other Aquatic Organisms/"Oyster Propagation"

Louisiana's chronic criterion-concentration for fecal coliform bacteria in shellfish harvesting areas (14 MPN/100 mL) is identical to EPA's. There is no EPA criterion comparable to Louisiana's acute fecal criterion, which states that "not more than ten percent of samples shall exceed 43 per 100 ml [of fecal coliform bacteria in shellfish harvesting areas]…"

c) Human Health: Drinking Water Supply

Louisiana's criterion-concentration for fecal coliform bacteria in drinking water supply is a "density of 2,000/100 ml." By contrast, the threshold concentration in the Maximum Contaminant Level (MCL) that EPA has issued under the Safe Drinking Water Act (SDWA) is "level of detection" (the lowest concentration at which the presence of the parameter of concern can be indicated, using currently-available analytic methods).

Direct comparison of these two concentrations is not entirely appropriate for at least two reasons. EPA's SDWA standard is for total coliform bacteria, rather than just fecal coliform bacteria. Yet more important is the fact that the EPA standard (detection of total coliform bacteria in no more than five percent of samples of finished drinking water) applies to finished (post treatment, including disinfection) drinking water supply, whereas the state's criterion applies to raw (untreated) drinking water supply.

d) Human Health: Water-contact Recreation / "Primary Contact Recreation," "Secondary Contact Recreation"

The state's acute criterion for fecal coliform bacteria applicable to waters with the designated use "recreation" has the same criterion-concentration (400/100 ml) as EPA's corresponding criterion. However, it does have a different frequency of acceptable excursions above the criterion-concentration; 25% rather than 10% (See Section C(4) "Articulation of Criterion-Frequency" below).

Louisiana has no chronic criterion for fecal coliform bacteria for this category of use.

e) Industrial Water Supply

Not applicable. There are no traditional pollutants for which both EPA and Louisiana have adopted criterion for this use.

f) Agricultural Water Supply / "Agriculture"

Not applicable. There are no traditional pollutants for which both EPA and Louisiana have adopted criterion for this use.

3) *Articulation of Criterion-Duration*[27]

[27] According terminology employed in some EPA guidance, the criterion-duration portion of a numeric WQC specifies the length of an "excursion" – the time period over which waterbody concentration of a pollutant is higher (or in the case of dissolved oxygen, lower) than the criterion-magnitude. For instance, EPA's chronic aquatic life

Most of Louisiana's WQC for "traditional" pollutants lack a clearly-stated criterion-duration.

a) Aquatic Life / "Fish and Wildlife Propagation"

While several of Louisiana's dissolved oxygen criteria for its "Fish and Wildlife Propagation" designated use ("not less than __ mg/L, at any time") have a clearly stated duration of an instant, the criterion-duration for a number of other pollutants are less clear. For example, the pH criterion is stated as: "The pH shall fall within the range of 6.0 and 9.0"; the temperature criterion is stated as: "maximum temperature of 32.2^{o} C (90^{o} F)"; and one of the DO criteria is stated as: "the DO concentration shall be at or above five mg/L." In these cases, there is no indication that the cited values are anything other than levels not to be ever exceeded, not even for a second; hence, a default criterion-duration of "instantaneous" is assumed.

Louisiana has a criterion for pH that states, "No discharge of wastes shall cause the pH…to vary by more than one pH unit within the specified pH range." Similar to this is the criterion for temperature, which specifies a "maximum of 2.8^{o} C (5^{o} F) rise above ambient." These are examples of what this report calls "quasi-numeric" criteria; such criteria are expressed in terms of a certain change from background conditions. Unlike the case of typical numeric WQC, determination of whether such criteria have been exceeded requires knowledge of not only current but also past water quality (or current concentration above and below a discharge or point of loading of) standard is intended to apply. It would presumably apply to the overall natural background pattern of temperature, over time and space. Hence, attention would need to be paid not only to the instantaneous minimum temperature levels, but also pollutants to a waterbody). Also, the wording of such criteria provides no indication as to what duration(s) of time the "no change average temperatures over various periods of time" (minutes, hours, days, etc).

It is particularly difficult to discern the applicable criterion-duration for chlorides, sulfates, and total dissolved solids (TDS). On the one hand, Subsection 1113.C.2 of the Louisiana WQS regulations says that human activities "shall not cause instream concentrations to exceed ___," which implies that an instantaneous duration applies. On the other hand, the language "numerical parameters for these parameters generally represent the geometric mean of existing data" also appears in this same Subsection, which indicates an open ended criterion-duration that is equivalent to a "long term average."

b) Human Health: Drinking Water Supply / "Drinking Water Supply"

The criterion-duration in the Louisiana drinking water supply criterion for fecal coliform bacteria that is expressed as "no more than 30 percent of the total samples collected on a monthly or near-monthly basis shall exceed a fecal coliform density of 2,000/100mL" would appear to be

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WQC for toxic chemicals have a criterion-duration of four days, which results in their being expressed as four day average concentrations. The occurrence of one or more excursion (e.g., a four day period in which the instream concentration, for example, of cyanide was higher than the criterion-concentration of 5.2 µg/L) would not necessarily represent failure to meet WQC. Only when the rate at which excursions occur is higher than that specified by the criterion-frequency has an actual exceedance of a water quality criterion occurred

a second or an instant. This is because of the reference to a percentage of samples.[28] Most ambient monitoring for bacteria takes the form of "grab" sampling, which involves collecting a series of single aliquots of water, by manual or mechanical means. It takes only a second to reach into the water and grab each of these individual measurements; hence, the assumption that the duration of concern is an instant or a second.

Louisiana has no chronic WQC for fecal coliform bacteria.

c) Human Health: Consumption of Fish and Other Aquatic Organisms / "Oyster Propagation"

As EPA has done, the Louisiana's chronic criterion for fish consumption is expressed as a median value with no indication of the duration of time to which this "average" value would apply.

d) Human Health: Water-contact Recreation / "Primary Contact Recreation," "Secondary Contact Recreation"

Louisiana has a criterion for fecal coliform bacteria that is stated as: "No more than 25 percent of the total samples collected on a monthly … basis shall exceed a … density of 400/100 ml."[29] The criterion-duration for this WQC would appear to be a second or instant. This is because of the reference to a percentage of samples. Most ambient monitoring for bacteria takes the form of "grab" sampling, which involves collecting a series of single aliquots of water, by manual or mechanical means. It takes only a second to reach into the water and grab each of these individual measurements; hence, the assumption that the duration of concern is an instant/second.

e) Industrial Water Supply

Not applicable. Louisiana does not have any criteria applicable to traditional pollutants for this use.

f) Agricultural Water Supply / "Agriculture"

See discussion of the criteria for chloride, sulfates, and TDS under the discussion of the criterion-duration for aquatic life in Subsection B(3)(a) above.

[28] Technically, this is not a water quality criterion because it describes the characteristics of a set of samples taken from a waterbody, rather than the desired condition of the waterbody itself. A true WQC would state something along the line of: "The density of E.coli in surface waters shall be higher than 1260 organisms/100 ml. no more than 10% of the time." What is presented as a WQC appears to be more like a waterbody assessment methodology, a proscribed means of interpreting data collected from a waterbody in order to infer the true (but never completely knowable, with current technology) condition of the waterbody over time and space.

[29] Ibid

4) *Articulation of Criterion-Frequency*[30]

All of the WQC for "traditional" pollutants examined, with the exception of fecal coliform bacteria, lack any statement regarding a criterion-frequency. Frequency of zero has been assumed as the default criterion-frequency.

Louisiana's fecal coliform criteria for primary and secondary contact recreation strongly imply[31] a frequency of excursions in a waterbody of no more than 25 percent. Louisiana's drinking water supply "criterion" strongly implies a 30 percent rate of excursion above the criterion-concentration in the waterbody serving as raw water supply.

5) *Discussion: Traditional Parameters*[32]

Louisiana has adopted numeric WQC for a relatively small portion of the traditional parameter/use combinations for which EPA has issued WQC. EPA has issued such values for about two dozens pollutants/parameters, some of which have criteria for more than one designated use.

Most significant to the state's coverage of traditional pollutants is the absence of numeric criteria for nutrients (phosphorous and nitrogen) or for chlorophyll a, an indicator of the density of algae in water. The algal blooms resulting from excess loadings of nutrients can adversely impact not only aquatic life, but also impair use of waters for water-based recreation and public water supply.

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[30] In EPA water quality standard terminology, the criterion-frequency specifies the maximum rate at which "excursions" can occur and the waterbody of concern can still fully support the designated use to which the criterion applies. For instance, EPA guidance specifies a criterion-frequency of once in three years for both its acute and chronic aquatic life WQC for toxic chemicals. This means that only if two or more excursions occur during any three year period has there actually been an exceedance of the WQC in question. For example, only if the four-day average concentration of , say, cyanide in a lake were higher than the chronic criterion-concentration of 5.2 µg/L more than once in three years would there have been failure to meet the EPA chronic aquatic life WQC.

[31] The term "strongly imply" rather than the term "specify", has been used with regard to the criterion-frequency because, as noted previously, these particular "criteria" are presented in the form of a water quality assessment methodology. That is, they indicate that no more than ten percent of samples collected have a density of the indicator bacteria higher than the criterion-concentration. It seems reasonable to assume that a "10% of samples" data interpretation rule was chosen by the state because the intent was to determine whether or not the waterbody concentration of the indicator bacteria went above the criterion-concentration more than ten percent of the time. Since a key purpose of CWA-related ambient monitoring is to determine whether or not water quality criteria have been exceeded, it seems reasonable to believe that the assessment methodology (no more than ten percent of samples) infers a WQC of "bacterial densities in waterbodies shall not go above (criterion-concentration) more than 10% of the time". This, in turn, implies a criterion-frequency of ten percent

[32] For purposes of this ELI report, "traditional pollutant/parameter" refers to a number of pollutants and water quality parameters that were recognized as significant contributors to and indicators of degradation of the condition of surface water well before passage of the Clean Water Act in 1972. As used in this study, "traditional pollutant" includes those pollutants/parameters referred to as "conventional" in the CWA and EPA regulations and guidance, which includes: biochemical oxygen demand (BOD), dissolved oxygen (DO), pH, total suspended solids (TSS), bacteria and other pathogens, and temperature. Also considered "traditional" in this document are several other non-toxic pollutants and parameters including alkalinity, chloride, chlorophyll a, color, dissolved solids, hydrogen sulfide, (total) nitrogen, oil and grease, total phosphorus, and turbidity, which are sometimes called "non-conventional" or "non-priority" in the EPA literature. Also, one "non-priority" toxic chemical, ammonia, is discussed under the heading "traditional pollutants/parameters."

Despite this lack of numeric criteria relevant to eutrophication, the state has included on its 303(d) list of impaired waters 95 assessment units for nutrients. These listings reflect the willingness of the state to put waters on the 303(d) list based on conditions considered inconsistent with one or more narrative WQC. Nevertheless, the adoption of numeric nutrient WQC would likely eventually result in the identification of additional nutrient-impaired waters. "Nutrients" are among the five most frequently mentioned causes of impairment for waters on state 303(d) lists nationwide, along with sediments, pathogens, mercury, and metals other than mercury.[33]

Also of note is the absence of a chronic fecal coliform criterion applicable to both primary and secondary contact recreation. EPA has a 30-day criterion-concentration for this bacterial indicator, as well as for *E. coli* and Enterococci. (EPA has put chronic criteria for Enterococci in place for Louisiana's coastal bathing areas, as required by Congressional statute.) In addition, Louisiana has no criterion for ammonia, one of the most commonly discharged pollutants to surface waters nationwide according to EPA's Toxics Release Inventory.

On the other hand, the state does have acute and "quasi-numeric" [34]criteria for one indicator of sediments/sedimentation, turbidity (in NTUs), and has listed "turbidity" as the reason for placing 26 waterbodies on its 303(d) list.

Louisiana lacks public water supply criteria for seven of the eight traditional parameters for which EPA has somewhat relevant standards. However, given that EPA has not issued actual water quality criteria for public water supply (i.e. raw water used by drinking water utilities use), and that all public water supplies serving more than 25 connections are covered by Safe Drinking Water Act regulations for finished (treated, at the tap) drinking water, the lack of public water supply criteria probably has little effect on human health. On the other hand, high levels of contaminants in raw water supplies can increase the cost of meeting such federal drinking water standards.

Most of the criterion-concentrations in Louisiana's WQC for traditional pollutants/parameters are comparable to the criterion-concentrations in corresponding EPA criteria and those adopted by the other nine states covered by this ELI report, though some of the criterion-concentrations for dissolved oxygen, chlorides, sulfates, and TDS are significantly different from EPA's. One possible explanation for this is that Louisiana waters may have naturally high/low levels of these pollutants/parameters.

An important factor regarding setting of aquatic life WQC is that ecologically-appropriate levels of traditional pollutants and other water quality parameters (e.g., temperatures and dissolved oxygen) can differ from one type of waterbody to another. State-specific, watershed-specific, or even waterbody-specific reasons (natural differences in water column chemistry, temperature, stream flow patterns, resident species of aquatic life) are the explanation for this phenomenon. Louisiana has adopted a substantial number of such site-specific WQC.

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[33] EPA National Section 303(d) List Fact Sheet: Causes of Impairment. Available at: http://iaspub.epa.gov/waters/national_rept.control#TOP_IMP

[34] In this report a "quasi-numeric" criterion is one that is expressed as a specific change from background conditions. Unlike the case of typical numeric WQC, determination of whether such criteria have been exceeded requires knowledge of not only current but also past water quality (or current concentration above and below a discharge or point of loading of pollutants to a waterbody). For example, a "quasi numeric" criterion for temperature might read "no more than a 1^{o}C increase above background temperature." Also, there is no indication as to what duration(s) of time the "no change" standard is intended to apply. It would presumably apply to the overall natural background pattern of temperature, over time and space. If so, attention should be paid not only to the instantaneous temperature levels, but also average temperatures over various periods of time (minutes, hours, days, etc.).

Table 3 of the state's WQS regulations presents waterbody-specific criterion-concentrations for chloride, sulfate, dissolved oxygen, pH, bacteria, temperature and total dissolved solids for nearly 500 waterbodies and portions of waterbodies.

Some of the state's numeric WQC for traditional pollutants has clearly-stated criterion-durations[35] while others do not. For example, one of the state's Fish and Wildlife Propagation WQC reads, "Dissolved oxygen concentrations in estuarine waters shall not be less than 4.0 mg/L at any time." This wording clearly indicates a criterion-duration of an instant. But, there are other WQC for traditionals that simply refer to maximum (or minimum for dissolved oxygen) concentrations, without making any mention of a duration or averaging period. In such cases, a criterion-duration of an instant is assumed. Another example of an implied duration of an instant is provided by criteria for fecal coliform bacteria that read: "No more than ___ percent of the total samples collected on a monthly … basis shall exceed a … density of ___ /100 ml."[36] The criterion-duration for this WQC would appear to be an instant because of the reference to a percentage of samples. Most ambient monitoring for bacteria takes the form of "grab" sampling, collecting a series of single aliquots of water, by manual or mechanical means. It takes only a second to reach into the water and grab each of these individual measurements; hence, the assumption that the duration of concern is an instant/second.

Looking at chronic WQC for traditional pollutants/parameters, Louisiana's criteria for chlorides, sulfates, and dissolved solids which the WQS regulations say "represent the arithmetic mean of existing data." The state's fecal coliform WQC for Oyster Propagation is phrased similarly. Such wording has the effect of creating an open-ended criterion-duration, since the span of time over which data will be averaged will depend, for a given water, on the period of time over which monitoring happens to have taken place. There are no Louisiana chronic WQC for traditionals with clearly defined criterion-duration.

Of all the types of WQC specified in Louisiana's WQS regulations, only the criteria for fecal coliform bacteria applicable to primary and secondary contact recreation, drinking water supply, and oyster propagation have an explicitly-stated criterion-frequency.[37] None of the other WQC for traditional pollutants contain reference to a criterion-frequency.

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[35] According terminology employed in some EPA guidance, the criterion-duration portion of a numeric WQC specifies the length of an "excursion" – the time period over which waterbody concentration of a pollutant is higher (or in the case of dissolved oxygen, lower) than the criterion-magnitude. For instance, EPA's chronic aquatic life WQC for toxic chemicals have a criterion-duration of four days, which results in their being expressed as four day average concentrations. The occurrence of one or more excursion (e.g., a four day period in which the instream concentration of cyanide was higher than the criterion-concentration of 5.2 µg/L) would not necessarily represent failure to meet WQC. Only when the rate at which excursions occur is higher than that specified by the criterion-frequency has an actual exceedance of a water quality criterion occurred.

[36] Technically, this is not a water quality criterion because it describes the characteristics of a set of samples taken from a waterbody, rather than the desired condition of the waterbody itself. A true WQC would state something along the line of: "The density of E.coli in surface waters shall be higher than 1260 organisms/100 ml. no more than 10% of the time." What is presented as a WQC appears to be more like a waterbody assessment methodology, a proscribed means of interpreting data collected from a waterbody in order to infer the true (but never completely knowable, with current technology) condition of the waterbody over time and space.

[37] In EPA WQS terminology, the criterion-frequency specifies the maximum rate at which "excursions" (see footnote 11) can occur and the waterbody of concern can still fully support the designated use to which the criterion applies. For instance, EPA guidance specifies a criterion-frequency of once in three years for both its acute and chronic WQC for toxic chemicals aimed at aquatic life protection. This means that only if two or more excursions occur during any three year period has there actually been an exceedance of the WQC in question. For example, only if the four-day average concentration of cyanide in a lake were higher than 5.2 µg/L more than once in three years would there have been failure to meet the EPA chronic aquatic life WQC.

As noted previously, the degree of protection provided by any state's WQC in relation to corresponding EPA criteria requires looking not only at the criterion-concentration, but also the criterion-duration and criterion-frequency in each of criteria being compared. If indeed the criterion-concentration, criterion-duration and criterion-frequencies of the state and EPA are identical, then the WQC will provide equal levels of protection. Unfortunately, because there are no traditional pollutants/parameters for which both the state and EPA have clearly-articulated criterion-durations and criterion-frequencies, such direct analysis is not possible. Nevertheless, looking at, for instance, the Louisiana and EPA dissolved oxygen WQC for freshwater aquatic can be useful, if one assumes that both Louisiana's and EPA's aquatic life WQC have a criterion-duration of an instant and a criterion-frequency of zero – a reasonable assumption given that both make no reference to a criterion-duration (or averaging period) or criterion-frequency. If these assumptions were correct, then the two criteria would provide equal levels of protection to aquatic life, because the criterion-concentration for both WQC is 5.0 mg/L. If, however, a WQC for a traditional pollutant had a lower criterion-concentration, but identical criterion-duration and criterion-frequency to EPA's WQC, then it would clearly provide a greater level of protection. There are no examples of this latter pattern for WQC for traditional parameters in Louisiana's WQS regulations.

Of course, there are additional combinations of criterion-durations and criterion-frequencies that would clearly indicate that one criterion is more protective than another. For example, if a state criterion had a criterion-duration the same as that of EPA's corresponding WQC, but a higher criterion-frequency than that of the corresponding EPA criterion, then it would clearly provide a lower level of protection than EPA's. For instance, Louisiana has a WQC for fecal coliform bacteria applicable to waters designated Primary Contact Recreation: "No more than 25 percent of the samples shall exceed a fecal coliform density of 400/100 ml. The corresponding EPA criterion reads, "nor shall more than 10% of the samples exceed 400/100 ml." Because the concentrations are identical, as well as the apparent duration (an instant), but Louisiana's WQC accepts a frequency of excursions[38] over twice as high as the EPA WQC, the state's WQC provides a lower level of protection to swimmers.

Louisiana's default (applies to waters for which no waterbody-specific WQC have been adopted) aquatic life criterion for chlorides provides an example of a state criterion-concentration is slightly lower that in the EPA WQC, the duration is longer, and the frequency is lower. The state's criterion-concentration is 250 mg/L, compared to EPA's 230 mg/L. The state's criterion-duration is entirely open-ended (average of all available data) while the duration for EPA's chronic aquatic life WQC is 96 hours. The state makes no mention of a criterion-frequency, which is assumed to mean a criterion-frequency of zero, while EPA specifies a maximum frequency of one excursion in any three-year period. It is impossible to determine, just by looking at the state and the EPA WQC, whether the more protective effect of the state's somewhat lower criterion-frequency would be offset by the reduced protection resulting from the somewhat higher criterion-concentration and the potentially much longer criterion-duration. The collection of additional laboratory and/or field data effects different combinations of concentration, duration, and frequency of exposure to chlorides would be studied. Several other combinations of relative concentrations, durations, and frequencies between WQC also present a complex situation. See Appendix C for a chart listing all the possible combinations of the three

[38] As used in this report, and in some EPA guidance documents, an "excursion" is any period equal in length to the criterion-duration of a WQC when the average waterbody concentration is higher than the criterion-concentration.

components of a properly-articulated numeric WQC, and what they mean in terms of comparative levels of protection.

Further complicating this picture, with regard to aquatic life WQC, there could be state-specific, watershed-specific, or even waterbody-specific reasons (differences in water column chemistry, temperature, stream flow patterns, resident species of aquatic life) that a state criterion can have a criterion-concentration higher or lower than that for the corresponding EPA criterion and still provide aquatic life protection equal to that for which the EPA WQC was designed. This would not, however, mean that the two criteria would provide equal levels of protection to the relevant use. For example, in Table 3 of its WQS regulations, Louisiana lists site-specific dissolved oxygen criterion-concentrations for a number of waterbodies across the state. Quite a few have criterion-concentrations between 2.0 mg/L and 4.0 mg/L, both of which are lower than the criterion-concentration in EPA's sole WQC for dissolved oxygen, which has a criterion-concentration of 5.0 mg/L. Neither the state nor EPA spell out a criterion-duration or criterion-frequency for their dissolved oxygen WQC; hence, for purposes of this discussion, a duration of an instant and a frequency of zero are assumed to both the state's and the federal agency's WQC. Clearly, if the EPA WQC, with its criterion-concentration of 5.0, were applied to any given waterbody, it would likely provide greater protection than a WQC with a criterion-concentration of, say 3.0 mg/L. If indeed the natural level of dissolved oxygen goes down to, but never below, 3.0 mg/L, then the aquatic organisms in that environment would have evolved the ability to live and reproduce in such conditions. Hence, application of a criterion for dissolved oxygen of "instantaneous concentration shall at no time go below 5.0 mg/L" would likely provide not only greater protection than the state WQC with the lower dissolved oxygen concentration. But also an even higher level of protection than that for which EPA designed its WQC. The effect of the state's lower criterion-concentration of dissolved oxygen would be to bring the level of protection back down to that intended by EPA.

Louisiana's Oyster Propagation and EPA's corresponding "shellfish harvesting" criteria for fecal coliform bacteria offer examples of human health WQC lacking a clearly defined criterion-duration and criterion-frequency. Both are expressed as "The median fecal coliform MPN (most probable number) of the water shall not exceed fourteen per 100 mL." Clearly, this is not intended as an instantaneous, never to surpass bacterial density; rather, it refers to a central tendency over some longer period of time. Unfortunately, neither the state nor the federal agency WQC specify the averaging period (i.e., criterion-duration). Assuming that the criterion-frequency for both the Louisiana and the EPA WQC are zero, then the relative degree of protection afforded to humans who eat shellfish taken from waters with this use designation will depend on the criterion-durations. If they are identical (for example, seven days), then the level of protection resulting from attainment of the two WQC would be the same; the criterion-concentration, criterion-duration and criterion-frequency of the two WQC would be identical. But, if the state's criterion-duration were shorter (for instance, 24 hours) then its criterion would be the more protective. Concentration and frequency would be identical, state duration would be shorter. On the other hand, if Louisiana's criterion-duration were longer, (for example, 30 days) then its WQC would be less protective. Concentration and frequency would be identical, state duration would be longer.

Absence of clearly-stated criterion-durations and criterion-frequencies also can render considerably more challenging the implementation of CWA programs that are driven largely by WQC (Section 303(d) and 305(b) assessment and reporting, TMDLs, and water quality-based NPDES permitting programs). Clearly, it would be difficult for someone implementing one of

these "downstream" CWA programs to deal with a WQC having a criterion-concentration reading "not too high" or "levels no greater than approximately 40 µg/L - 60 µg/L." Though perhaps less immediately obvious, imprecisely stated criterion-durations and criterion-frequencies can pose similar challenges to those presented by missing or vaguely stated criterion-magnitudes. For example, if over some 30 day period, four grab samples had been collected and analyzed for levels of a certain pollutant, and one of those samples had a concentration higher than a relevant criterion-concentration, the answer to the question "Was this pollutant exceeded this WQC?" would differ depending on the criterion-duration and criterion-frequency. If the duration were instantaneous and the frequency zero, the WQC would have been exceeded, without question.[39] But, if the duration were 30 days and the frequency remained at zero, the mere fact that one out of four instantaneous measurements surpassed the criterion concentration would not prove that an exceedence had occurred. Rather, only if the average of the concentrations in the four samples were higher than the criterion-concentration would there be strong evidence of an exceedence of WQC in the water from which said samples were collected. And, if the criterion-frequency were "two or more times per year," then one might not conclude that WQC exceedence had occurred based on the above evidence.[40]

D. Criteria for Toxic Chemicals[41]

1) *Coverage*

a) Aquatic Life – Freshwater / "Fish and Wildlife Propagation"

Acute Toxicity

Louisiana has adopted acute freshwater aquatic life criteria for 44 pollutants. Louisiana has not adopted, nor proposed, acute freshwater aquatic life criteria for thirteen toxic pollutants for which EPA has issued[42] corresponding Section 304(a) criteria (Appendix B, Table 1). The

[39] This statement assumes that all four of the samples passed the state's quality assurance/quality control (QA/QC) tests.

[40] The phrase "might not conclude" was employed because it would be contrary to the laws of probability to conclude that no additional excursions (30-day periods with average bacterial concentrations about the criterion-concentration) had occurred during any twelve month period encompassing the 30 days in which the four grab samples had been collected, based on the information presented herein. In fact, if these four individual samples were the only ones gathered during a given twelve month period, then it is quite likely that additional excursion did occur. The reason for this inference is that , given that there are 336 30-day periods in any twelve-month period, the odds of having randomly chosen to collect samples during the only 30-day period in which an excursion occurred are very low. Several times lower than randomly selecting a card from a well-shuffled deck of 52, and having that card turn out to be one named in advance.

[41] In this report, the term "toxic pollutant" includes not only EPA's "priority" toxic pollutants but also all those toxics called – for CWA purposes – "non-priority" pollutants, as well as all toxic chemicals falling into neither of these two EPA classifications. The one exception being ammonia; which is addressed under "traditional pollutants" in this report.

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[42] Throughout this report, the criteria recommended by EPA will be referred to as the EPA's "issued" or "published" criteria, interchangeably.

majority of these are synthetic organic substances, including a number of organophosphate and organochloride pesticides.

On the hand, Louisiana has adopted acute freshwater aquatic life criteria for 26 pollutants for which the EPA has not issued corresponding Section 304(a) criteria (also referred to as "extra pollutants" herein). The majority of these "extra pollutants" are synthetic organic chemicals, including a number of pesticides (Appendix B, Table 4).

Chronic Toxicity

Louisiana has adopted chronic freshwater aquatic life criteria for 43 pollutants.The state has not adopted, nor proposed, chronic freshwater aquatic life criteria for eighteen of the 35 toxic pollutants for which EPA has issued corresponding Section 304(a) criteria, several of which are organophosphates pesticides, organochloride pesticides, and toxic metals (Appendix B, Table 1).

On the other hand, Louisiana has adopted chronic freshwater aquatic life criteria for 26 pollutants for which EPA has not published corresponding Section 304(a) criteria (Appendix B, Table 4). The majority of these "extra pollutants" are the same synthetic organic chemicals for which Louisiana has adopted acute freshwater aquatic life criteria whereas EPA has not.

b) Aquatic Life – Marine Water / "Fish and Wildlife Propagation"

Acute Toxicity

Louisiana has adopted acute marine water aquatic life criteria for 40 pollutants. Louisiana has not adopted, nor proposed, acute marine water aquatic life criteria for eleven of the 33 toxic pollutants for which EPA has issued criteria (Appendix B, Table 1).

Louisiana has adopted acute marine water aquatic life criteria for 23 pollutants for which EPA has not issued Section 304(a) criteria. Many of these "extra pollutants" are synthetic organic chemicals, including a number of pesticides (Appendix B, Table 4).

Chronic Toxicity

Louisiana has adopted chronic marine water aquatic life criteria for 37 pollutants. The state has not adopted, nor proposed, chronic marine water criteria for eighteen (Appendix B, Table 1) of the 33 toxic pollutants for which EPA has issued corresponding criteria.

The state has also adopted chronic marine water aquatic life criteria for 22 pollutants for which EPA has not published corresponding criteria. Except for the absence of PCBs, these "extra pollutants" are the same synthetic organic substances for which Louisiana has adopted acute marine water aquatic life criteria where EPA has not (Appendix B, Table 4).

c) Aquatic Life – Brackish Water / "Fish and Wildlife Propagation"

There are also acute and chronic criteria for which Louisiana has adopted for aquatic life protection in brackish waterbodies. Because there are no corresponding EPA criteria, these criteria were not included in this review.

d) Human Health: Consumption of Fish and Other Aquatic Organisms

Louisiana has no WQC for toxic chemicals that apply solely to exposure of humans to toxic chemicals via consumption of aquatic organisms from a given waterbody; rather, it has a set of criteria aimed at protecting humans who use a given waterbody not only for fish consumption but also for water-contact recreation (see Subsection D(1)(g) below).

EPA, on the other hand, has adopted human health WQC aimed at fish/aquatic organism consumption alone, so-called Human Health: Organisms (HHO) criteria. (EPA has not issued any WQC for toxic chemicals directed at water-based recreational use, either alone or in combination with other human health-related uses.)

Technically, Louisiana lacks WQC for all 106 of the pollutants for which EPA has issued HHO (fish consumption) criteria; however, it is probably more instructive to compare Louisiana's Human Health: Non-Drinking Water Supply criteria to EPA's Human Health: Organisms only (HHO) criteria, as is done in Subsection D(1)(g), below.

e) Human Health: Drinking Water Supply[43]

Louisiana has no WQC for toxic substances applicable solely to the Drinking Water Supply designated use. It does, however, have WQC for this use, in combination with two additional uses: 1) consumption of fish and other aquatic organisms, and 2) water contact recreation.

Similarly, EPA has no Section 304(a) criteria for toxic pollutants that apply solely to drinking water supply use. However, EPA has promulgated Primary Drinking Water Standards applicable to finished drinking water (as opposed to raw source water) for 77 toxic pollutants. The federal agency also has issued WQC for over 100 toxic chemicals, applicable to drinking water combined with consumption of fish and other aquatic organisms. (See subsection "f", immediately below.)

f) Human Health: Consumption of: 1) Water, plus 2) Fish and Other Aquatic Organisms

Louisiana has not adopted, nor proposed, WQC for toxic chemicals aimed at protection of humans using a waterbody for both drinking water supply (DWS) and consumption of fish, shellfish, and other aquatic organisms (FC). The state does have criteria for these two uses, plus water contact recreation (see Subsection D(1)(h) below).

EPA, on the other hand, has adopted human health WQC aimed at combined drinking water supply and fish/aquatic organism consumption – so-called Human Health: Water and Organisms (HHWO) criteria. (EPA has not issued any WQC for toxic chemicals directed at water-based recreational use, either alone or in combination with other human health-related uses).

Technically, Louisiana lacks WQC for all 113 of the pollutants for which EPA has issued HHWO (drinking water supply plus fish consumption) criteria; however, it is probably more instructive to compare Louisiana's Human Health: Drinking Water Supply criteria to EPA's

[43] Louisiana has a set of criteria labeled "Human Health Protection: Drinking Water Supply", but the title does not accurately describe the uses which these criteria are aimed at protecting. As specified in footnote 2 to Table 1 in the state's WQS regulations, these criteria actually address the combination of drinking water supply and two other uses: 1) fish consumption, and 2) water contact recreation. These criteria are addressed in Section (D)(1)(h)

Human Health: Water and Organisms (HHO) criteria, as is done in Subsection D(1)(h), immediately below.

g) Human Health: Fish Consumption and Water Contact Recreation / "Human Health Protection: Non-Drinking Water Supply"[44]

Louisiana has human health criteria for surface water bodies aimed at protecting people engaged in the combination of two uses: 1) fish consumption and 2) water-contact recreation for 39 toxic pollutants, called Human Health Protection: Non-Drinking Water Supply. Of these, the criteria for five pollutants (benzene, bromodichloromethane, 1, 3-dichloropropene, total PCBs, and vinyl chloride) have been recently adopted.

There is no EPA criterion for toxic chemicals aimed at protecting the health of those who use a given waterbody for these two uses combined. EPA has, however, issued criteria for 106 toxic chemicals aimed solely at fish consumption, often referred to as Human Health: Organisms (HHO). None of EPA's criteria for toxic chemicals relate to water-contact recreation, either alone or in combination with other uses. These HHO criteria that EPA has published are used in this report for comparison with Louisiana's "Human Health Protection: Non-Drinking Water Supply" criteria.

There are 69 pollutants for which Louisiana has not adopted, nor proposed, Human Health Protection: Non-Drinking Water Supply criteria, for which EPA has issued its HHO criteria (Appendix B, Table 3). The majority of these pollutants are synthetic organic chemicals, including many known or suspected carcinogens and/or bioaccumulators. A number of polynuclear aromatic hydrocarbons (PAHs), which fall into categories of chemicals that are frequently mentioned as potential endocrine disruptors, are also among the pollutants lacking this type of state criteria.

Of the pollutants for which Human Health Protection: Non-Drinking Water Supply criteria exist in the Louisiana WQS regulations, there are four for which the EPA has not issued corresponding Section 304(a) HHO criteria. They are endosulfan, 2-(2, 4, 5-Trichlorophenoxy) propionic acid, and 2,4-Dichlorophenoxyacetic acid, and Hexachloro-1,3-butadiene (Appendix B, Table 5).

h) Human Health: Drinking Water Supply, Fish Consumption, and Water-Contact Recreation/ "Human Health Protection: Drinking Water Supply"[45]

Louisiana has Human Health: Drinking Water Supply criteria, listed in Table 1 the WQS regulations, for 54 toxic pollutants. Of these, the criteria for seven pollutants (arsenic, 1, 3-dichloropropene, benzene, bromodichloromethane, total PCBs, vinyl chloride, and zinc) have been recently adopted.

[44] These criteria address the use combination of: 1) fish consumption and 2) primary and secondary contact recreation but not drinking water supply.

[45] Though the column containing the criterion-concentrations for these WQC in Table 1 of the Louisiana WQS regulations is labeled "Drinking Water Supply," footnote 1 to this same table clearly states that this set of WQC applies not only to drinking water supply use, but "also protect(s) for primary and secondary contact recreation and fish consumption."

There is no set of EPA criterion for toxic chemicals aimed at protecting persons using a given waterbody for the combination of these three uses. EPA, however, has issued criteria for 113 toxic chemicals to address human health risks associated with combined drinking water and fish consumption uses (labeled "HHWO for Human Health: Water and Organisms"). None of EPA's criteria for toxic chemicals relates to water-contact recreation, either alone or in combination with other uses. These EPA HHWO criteria are used in this report for comparison with Louisiana's Human Health Protection: Drinking Water Supply criteria.

There are 72 pollutants for which Louisiana has not adopted, nor proposed, Human Health Protection: Drinking Water Supply criteria for which EPA has published HHWO criteria (Appendix B, Table 2).

Other the other hand, the state has adopted Human Health: Drinking Water Supply criteria for thirteen pollutants for which the EPA has not issued HHWO criteria (Appendix B, Table 2).

i) Human Health: Water-Contact Recreation

Louisiana has no WQC for water-based recreation uses alone. See Subsection D(1)(g) and Subsection D(1)(h) above, which discuss criteria for which recreational uses are combined with one or two other uses.

j) Agricultural Water Supply /"Agriculture"

Louisiana has no WQC for toxic chemicals pertaining to its "agriculture" designated use. Similarly, EPA has no WQC for toxic chemicals applicable to agricultural uses.

k) Industrial Water Supply

Louisiana has no WQC for toxic chemicals pertaining to industrial water supply. Similarly, EPA has no WQC for toxic chemicals applicable to this use.

2) *Criterion-Concentrations[46], Compared to EPA's*

a) Aquatic Life – Freshwater / "Fish and Wildlife Propagation"

Acute Toxicity

Among the 44 pollutants for which Louisiana has adopted acute freshwater aquatic life criteria, eighteen pollutants have criteria that correspond to an EPA recommended criterion.[47] Within this subset, six pollutants have acute freshwater aquatic life criteria for which the criterion-concentrations are the same as the corresponding EPA values. Five pollutants have

[46] According to EPA guidance, numeric water quality criteria (WQC) consist of three components: 1) a criterion-magnitude, 2) a criterion-duration, and 3) a criterion-frequency. The first of these, criterion-magnitude, is usually expressed as a concentration; hence, the frequent use of "criterion-concentration" in this report. For some key water quality parameters, such as temperature and pH, quantity is not expressed as a concentration, so EPA employs the broader term "criterion-magnitude."

[47] The other 26 pollutants are those for which the EPA has not issued acute freshwater aquatic life criteria.

criteria for which the criterion-concentrations are lower than the corresponding EPA values (Appendix B, Table 7). Seven pollutants have criteria for which the criterion-concentrations are higher than EPA's criteria (Appendix B, Table 6).

Among those five pollutants for which the criterion-concentrations are lower than the corresponding EPA values, the criterion-concentration for chromium II is a value that has been recently adopted.

Among those seven pollutants for which the criterion-concentrations are higher than the corresponding EPA values, the criterion-concentration for nickel is a value that has been recently adopted.

Chronic Toxicity

Among the 43 pollutants for which Louisiana has adopted chronic freshwater aquatic life criteria, seventeen pollutants have criteria that correspond to the EPA's recommended criteria.[48] Within this subset, the chronic freshwater aquatic life criteria for seven pollutants have the same criterion-concentrations as the EPA's. Three pollutants have criteria for which the criterion-concentrations are lower than the corresponding EPA values (Appendix B, Table 7). Seven pollutants have criteria for which the criterion-concentrations are higher than the corresponding EPA values (Appendix B, Table 6).

Among those three pollutants for which the criterion-concentrations are lower than the corresponding EPA values, the criterion-concentration for zinc is a value that has been recently adopted.

Among those seven pollutants for which the criterion-concentrations are higher than the corresponding EPA values, the criterion-concentration for nickel is a value that has been recently adopted.

b) Aquatic Life– Marine Water / "Fish and Wildlife Propagation"

Acute Toxicity

Among the pollutants 40 pollutants for which Louisiana has adopted acute marine water aquatic life criteria, seventeen pollutants have criteria that are corresponding to the EPA's recommended criteria.[49] Within this subset, thirteen pollutants have criteria for which the criterion-concentrations are the same as the corresponding EPA values. Two pollutants have criteria for which the criterion-concentrations are lower than the corresponding EPA values (Appendix B, Table 7) and two pollutants (cadmium and mercury) have criteria for which the criterion-concentrations are higher than the corresponding EPA values (Appendix B, Table 6).

Chronic Toxicity

Among the pollutants 37 pollutants for which Louisiana has adopted chronic marine water aquatic life criteria, fifteen pollutants have criteria that correspond to the EPA's recommended criteria.[50] Within this subset, eleven pollutants have criteria for which the

[48] The other 26 pollutants are those for which the EPA has not issued chronic freshwater aquatic life criteria.
[49] The other 23 pollutants are those for which the EPA has not issued acute saltwater aquatic life criteria.
[50] The other 22 pollutants are those for which the EPA has not issued chronic saltwater aquatic life criteria.

criterion-concentrations are the same as the corresponding EPA values. Two pollutants have criteria for which the criterion-concentrations are lower than the corresponding EPA values (Appendix B, Table 7), and two pollutants (cadmium and copper) have criteria for which the criterion-concentrations are higher than the corresponding EPA values (Appendix B, Table 6).

c) Human Health: Consumption of Fish and Other Aquatic Organisms

Not applicable. Louisiana has no WQC for toxic chemicals that apply solely to exposure of humans to pollutants via the consumption of fish and other aquatic life forms caught in a given waterbody. However, the state does have WQC for consumption of aquatic organisms combined with water contact recreation use. See Subsection (f) below.

d) Human Health: Drinking Water Supply[51]

Not applicable. Louisiana has no WQC for toxic chemicals that apply solely to drinking water supply use.

e) Human Health: Consumption of: 1) Water plus 2) Fish and Other Aquatic Organisms

Not applicable. Louisiana has adopted no WQC for toxic chemicals aimed at protection of humans using a waterbody for both drinking water supply (DWS) and consumption of fish, shellfish, and other aquatic organisms. However, the state does have WQC for drinking water supply, consumption of aquatic organisms, and water contact recreation use. See Subsection (g) below.

f) Human Health: Fish Consumption and Water Contact Recreation/"Human Health Protection: Non-Drinking Water Supply"[52]

Among the pollutants 39 pollutants for which Louisiana has adopted "human health protection: non drinking water supply" criteria, 37 pollutants have numeric criteria that correspond to the EPA's human health criteria for consumption of aquatic organisms only (HHO).[53] Within this subset, 32 pollutants have criterion-concentrations that are lower than EPA's (Appendix B, Table 7). And among those 32 pollutants for which the criterion-concentrations in Louisiana's Human Health Protection: Non-Drinking Water Supply criteria are lower than the criterion-concentrations in EPA's Human Health: Organisms Only criteria, the criterion-concentrations for five pollutants (benzene, bromodichloromethane, vinyl chloride, 1,3-dichloropropene, and total PCBs) are recently adopted values.

[51] Louisiana has a set of criteria labeled "Human Health Protection: Drinking Water Supply", but the title does not accurately describe the uses which these criteria are aimed at protecting. As specified in footnote 2 to Table 1 in the state's WQS regulations, these criteria actually address the combination of drinking water supply and two other uses: 1) fish consumption, and 2) water contact recreation. These criteria are addressed in Section (D)(1)(h)

[52] The title of this set of WQC can be confusing. These criteria are actually aimed at protecting humans against the effects of the intake of toxic chemicals resulting from eating fish taken from a Louisiana waterbody, as well as engaging in water contact recreation.

[53] The other four pollutants are those for which the EPA has not issued "Human Health: Organisms Only" criteria.

On the other hand, five pollutants have Human Health Protection: Non-Drinking Water Supply criteria for which the criterion-concentrations are higher than criterion-concentrations in EPA's Human Health: Organisms Only criteria (Appendix B, Table 6). And of these five pollutants, two (dioxin and cyanide) have criterion-concentrations that are between one and two orders of magnitude higher than the corresponding EPA values. Dioxin has been found to be highly bioaccumulative.

g) Human Health: Drinking Water Supply, Fish Consumption, and Water-Contact Recreation/"Human Health Protection: Drinking Water Supply"[54]

Among the pollutants 54 pollutants for which Louisiana has adopted Human Health Protection: Drinking Water Supply criteria, 41 pollutants[55] have criteria that correspond to the EPA's HHWO criteria (for consumption of water plus aquatic organisms). Within this subset, 31 pollutants have criteria for which the criterion-concentrations are lower than that in the corresponding HHWO criteria published by EPA (Appendix B, Table 7); two pollutants have criteria for which the criterion-concentrations are equal to the corresponding EPA values; and eight pollutants have higher criterion-concentrations than the EPA's (Appendix B, Table 6).

Of note is the criterion-concentration in the Human Health Protection: Drinking Water Supply WQC covering dioxin and arsenic. The dioxin criterion has a concentration that is one order of magnitude higher than the corresponding EPA value. Dioxin has been found to be highly bioaccumulative. The arsenic WQC has a criterion-concentration that is two orders of magnitude higher than the corresponding EPA recommended value.

Among the 31 pollutants for which the criterion-concentrations are lower than the corresponding EPA values, the criterion-concentrations seven pollutants (arsenic benzene, bromodichloromethane, 1,3-dichlropropene, total PCBs, vinyl chloride, and zinc) are recently adopted values.

Among the eight pollutants for which the criterion-concentrations are higher than the corresponding EPA values, the criterion-concentration for arsenic is a recently adopted value.

h) Human Health: Water-contact Recreation

Not applicable. Louisiana has no WQC for water-based recreation uses alone. See Subsection D(1)(f) and Subsection D(1)(g) above, which discuss criteria for which recreational uses are combined with one or two other uses.

i) Industrial Water Supply

Not applicable. Louisiana does not have any WQC for toxic chemicals pertaining to use of waterbodies as a water supply for industrial operations.

[54] These criteria actually address the combination of drinking water supply and two other uses: 1) "fish" consumption, and 2) water contact recreation

[55] The other twelve pollutants are those for which the EPA has not issued chronic saltwater aquatic life criteria.

j) Agricultural Water Supply/ "Agriculture"

Not applicable. Louisiana does not have any WQC for toxic chemicals pertaining to use of waterbodies as a water supply for agricultural operations.

3) *Articulation of Criterion-Duration*[56]

a) Aquatic Life- Freshwater and Marine/ "Fish and Wildlife Propagation"

No clear indication of a criterion-duration applicable to acute aquatic life criteria is provided in the relevant table (Table 1), in the footnotes to said table, or in the definitions section of the Louisiana WQS regulations.

However, Section LAC33: IX.113.C(6)(b) does state that "the criteria for protection of aquatic life are based on acute and chronic concentrations in fresh and marine waters as specified in the EPA criteria documents." Based on this language, a duration equal to the criterion-duration for corresponding EPA criteria (one hour) has been assumed for the purposes of this report.

For the same reasons cited with regard to the acute aquatic life criteria for toxic pollutants, a duration equal to the criterion-duration for corresponding EPA criteria (four days/96 hours) has been assumed.

b) Human Health: Consumption of Fish and Other Aquatic Organisms

Not applicable. State has not adopted criteria for this particular combination of water uses.

c) Human Health: Drinking Water Supply

Not applicable. Louisiana has no WQC for toxic chemicals that apply solely to drinking water supply use.

d) Human Health: Consumption of: 1) Water plus 2) Fish and Other Aquatic Organisms

Not applicable. State has not adopted criteria for this particular combination of water uses.

[56] According terminology employed in some EPA guidance, the criterion-duration portion of a numeric WQC specifies the length of an "excursion," the time period over which waterbody concentration of a pollutant is higher (or in the case of dissolved oxygen, lower) than the criterion-magnitude. For instance, EPA's chronic aquatic life WQC for toxic chemicals have a criterion-duration of four days, which results in their being expressed as 4 day average concentrations. The occurrence of one or more excursion (e.g., a four day period in which the instream concentration, for example, of cyanide was higher than the criterion-concentration of 5.2 µg/L) would not necessarily represent failure to meet WQC. Only when the rate at which *excursions* occur is higher than that specified by the criterion-frequency has an actual exceedance of a water quality criterion occurred .

e) Human Health: Fish Consumption and Water Contact Recreation/ "Human Health Protection: Non-Drinking Water Supply"[57]

No clearly stated criterion-duration for Louisiana's human health criteria appears in Table 1, footnotes to Table 1, or in the "definitions" section of the Louisiana WQS regulations. However, LAC33: IX.113.C (6) (c) states, "The criteria for human health are derived using EPA guidelines, procedures, and equations…" (Possible assumptions of an applicable criterion-duration include: 1) an instant, 2) seven days, 3) one year (365 days), and 4) seventy years).

Furthermore, inference about duration from EPA's human health WQC is more difficult than from EPA's aquatic life WQC because the Agency's guidance per duration as applicable to its human health criteria is ambiguous. Some guidance suggests an instantaneous duration, other guidance language suggests an annual duration, and still other EPA text implies a 70 year duration (average human lifetime).

Still another way in which a concentration-duration is implied for Louisiana's human health criteria for toxic chemicals can be found in Table 2b of the Louisiana WQS regulations, "Waterbody Categorization for the Determination of Flow for Human Health," which lists the 7Q10 (lowest seven-day average flow occurring, on average, once in ten years) stream flow parameter for non-carcinogens and the harmonic mean flow parameter for carcinogens. The 7Q10 stream flow parameter suggests a criterion-duration of seven days. The harmonic mean flow parameter suggests a criterion-duration of at least one year, and possibly whatever the length of time for which flow data is available on each stream. (Possible assumptions include: 1) instantaneous, 2) seven days, 3) one year (365 days), and 4) seventy years).

f) Human Health: Drinking Water Supply, Fish Consumption, and Water-Contact Recreation/"Human Health Protection: Drinking Water Supply"[58]

See discussion of criterion-duration per the state's Human Health Protection: Non-Drinking Water Supply criteria, immediately above.

g) Human Health: Water-Contact Recreation

Not applicable. Louisiana has no WQC for water-based recreation uses alone. See Subsection D(1)(e) and Subsection D(1)(f) above, which discuss criteria for which recreational uses are combined with one or two other uses.

h) Industrial Water Supply

Not applicable. Louisiana does not have any WQC for toxic chemicals pertaining to use of waterbodies as a water supply for industrial operations.

[57] Id. at 32

[58] These criteria actually address the combination of drinking water supply and two other uses: 1) fish consumption, and 2) water contact recreation

i) Agricultural Water Supply

Not applicable. Louisiana does not have any WQC for toxic chemicals pertaining to use of waterbodies as a water supply for agricultural operations.

4) *Articulation of Criterion-Frequencies*[59]

None of Louisiana's numeric WQC for toxic chemicals have explicit criterion-frequencies.

a) Aquatic Life – Freshwater and Marine/ "Fish and Wildlife Propagation"

Given the lack of specificity in the Louisiana WQS regulations, a criterion-frequency of zero has been assumed as the default criterion-frequency for the purposes of this review. However, since, as noted earlier, Louisiana's WQS regulations do explicitly state that EPA's WQC for toxics were the basis of the state's aquatic life criteria for toxic pollutants, use of the same criterion-frequency as that of corresponding EPA criteria could, for the purposes of this report, be justified. Following this logic, a maximum frequency of excursions (conditions worse that those described by the combination of the criterion-concentration and criterion-frequency) of one in three years could be applied for both acute and chronic aquatic life criteria.

b) Human Health: Various Uses

Since neither Louisiana's WQS regulations nor EPA's water quality criteria guidance mentions a criterion-frequency (allowed rate of excursions), there seems to be no reason, or basis, to assume that any excursion is acceptable. A criterion-frequency of zero has been assumed as the default criterion-frequency for the purposes of this report.

A different concentration-frequency is implied for Louisiana's human health criteria for non-carcinogenic toxic chemicals in Table 2b of the Louisiana WQS regulations, "Water body Categorization for the Determination of Flow for Human Health," which lists the 7Q10 (lowest seven day average flow occurring, on average, once in ten years) stream flow parameter for non-carcinogens, carcinogens and the harmonic mean flow parameter for carcinogens. The 7Q10 stream flow parameter suggests a criterion-frequency of once in ten years.

5) *Discussion: Criteria for Toxic Chemicals*

Louisiana's WQS regulations contain aquatic life criteria for a large number of toxic pollutants. More than two dozens of these pollutants have criteria for which EPA has not issued corresponding criteria under the authority of Section 304(a) of the Clean Water Act. All of the

[59] In EPA water quality standard terminology, the criterion-frequency specifies the maximum rate at which "excursions" can occur and the waterbody of concern can still fully support the designated use to which the criterion applies. For instance, EPA guidance specifies a criterion-frequency of once in three years for both its acute and chronic aquatic life WQC for toxic chemicals. This means that only if two or more excursions occur during any three-year period has there actually been an exceedance of the WQC in question. For example, only if the four-day average concentration of, cyanide in a lake were higher than the chronic criterion-concentration of 5.2 µg/L more than once in three years would there have been failure to meet the EPA chronic aquatic life WQC.

"extra"[60] pollutants for which the state has adopted aquatic life criteria whereas EPA has not are synthetic organic compounds. Endosulfan, a pesticide that has been cited as a likely endocrine disruptor, is one of these pollutants.

On the other hand, the state has not adopted acute freshwater aquatic life criteria for more than a dozen pollutants for which EPA has issued corresponding criteria. It also has not established chronic freshwater aquatic life criteria for nearly two dozen pollutants, many of which are pesticides and/or persistent bioaccumulators such as diazinon, nonylphenol and tributyltin. A similar pattern holds for Louisiana's marine water aquatic life criteria.

A significant gap in the state's coverage of water quality criteria concerns those related to human health protection. Louisiana has adopted criteria for only 42% of the pollutants for which EPA has published "consumption of aquatic life" (HHO) criteria. Similarly, the state has adopted criteria for only 47% of the pollutants for which EPA has issued WQC to address use of waterbodies for the combined uses of drinking water and fish (and shellfish) consumption (HHWO). The majority of these pollutants are synthetic organic chemicals, including many known or suspected carcinogens and/or bioaccumulators. Among the pollutants lacking state criteria are benzo-a-pyrene and several other polycyclic aromatic hydrocarbons (PAHs), which are not only carcinogenic and bioaccumulative, but are also commonly found in urban stormwater and have been mentioned as potential endocrine disruptors. Also on the list of suspected endocrine disruptors are phthalate esters, five of which are among Louisiana's list of "missing" criteria. In addition, the state lacks human health criteria for heptachlor epoxide, methoxychlor, and pentachlorobenzene, pollutants reported to be associated with suspended materials in parts of the Mississippi River.

In theory, the absence of a human health criterion for a pollutant might not be important to ensuring that people are protected from exposure (via ingestion of drinking water and/or aquatic organisms) to levels that would pose a significant risk. In particular, if the state has an acute and/or a chronic aquatic life criterion for the pollutant with a criterion-concentration lower than that in EPA's human health criteria (and the state's aquatic life criterion-duration is equal to or shorter than that in EPA's human health criterion and the state criterion-frequency is equal to or lower than that in EPA human health criterion), attainment of the aquatic life criterion should ensure that waterbody levels of the pollutant would remain below those specified in EPA's human health criteria. In Louisiana's case, the metal nickel is the only pollutant for which the state lacks a human health criterion but has an aquatic life criterion. In this case, the criterion-concentrations for the state's chronic aquatic life criteria (160, 157 and 8.2 µg/L) are somewhat lower than the lowest EPA human health criterion-concentration (610 µg/l for the HHO designated use). Unfortunately, the state's aquatic life water quality criteria do not articulate the duration or frequency. However, if one assumes, that the criterion-duration for Louisiana's chronic aquatic life criteria is four days/96 hours and the duration for EPA's human health WQC is 365 days, then it would seem that the state's chronic aquatic life WQC for nickel provides a greater level of protection to human health than would either of EPA's human health criteria for this pollutant. Not only does the Louisiana criterion have a lower criterion-concentration, it also has a much shorter criterion-duration (four days versus 365 days). A confounding fact is that the assumed criterion-frequency for Louisiana's aquatic life criteria – no more than one excursion every three years, though a fairly low frequency – is still higher than what the criterion-frequency in EPA's human health criteria appears to be (zero, i.e., no excursions, ever). Most

[60] For the purposes of this report, "extra" criteria are those pollutant/use pairs for which the state has officially adopted criteria, but for which EPA has not issued corresponding criteria.

likely, the presumably higher criterion-frequency for Louisiana's criterion would not offset the combined effect of the considerably lower criterion-concentration and the substantially shorter criterion-duration, as compared to the comparable elements of EPA's human health criterion.

Where the state has adopted numeric criteria corresponding to EPA's freshwater aquatic life WQC, the criterion-concentrations in approximately two-third of these criteria are either equal to or only slightly less than the criterion-concentrations in the corresponding EPA criteria. The criterion-concentrations for the remaining one-third are higher than those in corresponding EPA criteria. Louisiana's criterion-concentrations for most of its marine water aquatic life criteria are either equal to or only slightly less than corresponding EPA values.

With regard to criterion-concentrations in human health criteria, where the state has adopted such criteria corresponding to the EPA's criteria, the criterion-concentrations for the majority of those criteria are lower than the criterion-concentrations of the corresponding EPA criteria. For those pollutants with human health-related criterion-concentrations that are higher than the EPA's, two are widely recognized as highly bioaccumulative (2,3,7,8 TCDD (dioxin) and endrin), and one (toluene) is listed as a potential bioaccumulative pollutant of concern by the Great Lakes Initiative and by the State of Arkansas.

Turning to the second key component of numeric WQC, the criterion-duration, as noted above, Louisiana's Fresh Water and Marine Water Aquatic Life Protection criteria[61] (Table 1 of the state's WQS regulation) do not articulate a criterion-duration. The absence of any reference to a specific duration, could be read to indicate a criterion-duration of an instant. However, language in the state's regulations, including direct reference to EPA's aquatic life criteria development methodology for toxic chemicals, could be taken to imply a criterion-duration of one hour for Louisiana's acute Aquatic Life Protection WQC for toxics and a criterion-duration of four days/96 hours for its chronic criteria for this use – the same criterion-durations EPA indicates for its acute and chronic aquatic life criteria, respectively.

As for its human health criteria[62] for toxic substances appearing in Table 1 of the WQS regulations, Louisiana's WQS regulations make no mention of a criterion-duration, which would seem to indicate a criterion-duration of an instant. However, the fact that the state's regulation make it clear that it the method for deriving its Human Health: Non-Drinking Water Supply and Human Health: Drinking Water Supply WQC on EPA's methodology for deriving its human health WQC for toxics. Unfortunately, unlike its aquatic life WQC for toxics, EPA guidance is not consistent as to a criterion-duration for its human health criteria; hence, in the absence of mention of a criterion-duration for Louisiana's human health WQC for toxic chemicals, a criterion-duration of an instant is assumed in this report.

With reference to criterion-frequency for the aquatic life and human health WQC[63] for toxics presented in Table 2, the regulations are silent. However, the clear reference to EPA's aquatic life criteria as the basis for the state's Fish and Aquatic Life (Fresh Water and Salt Water) WQC for toxics could be taken to suggest application of EPA's criterion-frequency for its toxics aquatic life criteria, maximum of one excursion in any three year period, to Louisiana's Aquatic Life Protection WQC for toxics. Unfortunately, unlike its aquatic life WQC for toxics, EPA guidance is silent as to an explicit criterion-frequency; hence, in the absence of mention of

[61] Actually, Table 1 of the Louisiana WQS regulations present only a set of criterion-concentrations. Lacking any reference to a criterion-duration and criterion-frequency, these are not really complete WQC.
[62] Ibid
[63] Ibid

a criterion-frequency for the human health WQC[64] appearing in Table 1of the Tennessee WQS regulations, a criterion-frequency of zero is assumed in this report.

As regards the degree of protection provided by a given EPA WQC for toxics pertaining to protection of aquatic life, assuming, as indicated above, that the criterion-durations and criterion-frequency for Louisiana's (Fresh Water and Marine Water) Aquatic Life Protection criteria are the same as those for the corresponding EPA criteria (acute criterion-duration of one hour, once in three years; chronic criterion-duration of 96 hours, once in three years),[65] one could conclude that the seven Louisiana acute Freshwater Aquatic Life Protection criteria with higher criterion-concentrations than those of corresponding EPA WQC are less protective than EPA's corresponding WQC. And, those five acute Freshwater Aquatic Life Protection with criterion-concentrations lower than to those of corresponding EPA WQC are more protective as their EPA counterparts. Finally, those six Louisiana criteria of this type with criterion-concentrations identical to those of the federal agency's corresponding WQC would provide equal protection. (The same conclusions could be drawn about the remainder of the state's WQC for Aquatic Life Protection for toxic chemicals, if the above assumptions are made: Louisiana WQC with higher criterion-concentrations will provide less protection, those with lower criterion-concentration will provide greater protection, and those with criterion-concentrations identical to EPA's will provide an equal level of protection.)

If, however, one took the absence of any mention of a criterion-duration with regard to the state's Aquatic Life Protection WQC for toxics to imply a criterion-duration of an instant, but continued to assume the criterion-frequency were the same as EPA's (maximum of one in three years) then any of the state's criteria for this use that had a criterion-concentration equal to or lower than that of the corresponding EPA criterion would definitely provide a higher level of protection to communities of aquatic life than would the EPA criterion. For example, ten of the chronic Freshwater Aquatic Life Protection would provide greater protection. If one also changed the assumed state criterion-frequency from once in three years to zero, this would render the Louisiana Aquatic Life Protection criteria with criterion-concentrations equal to or lower than those in EPA's WQC even more protective, in relation to those of the federal agency.

If, on the other hand, the criterion-duration for the state's acute Aquatic Life Protection criteria for toxics were assumed to be longer than the one hour for EPA's, but the criterion-frequency were assumed to be the same, this would tend to make the state's criteria less protective in general than if the duration were either an instant, or one hour. Assumption of a longer criterion-duration, say twelve hours, would also make it difficult to know, by just looking at the WQC themselves, whether the three state acute Marine Water Aquatic Life Protection WQC with a criterion-concentration lower than that of the corresponding EPA WQC would be more or less protective than EPA's aquatic life criterion. It would be hard to know whether the more-protective effect of the lower criterion-concentration would be offset by the longer criterion-duration, without having data on the toxic effects of a given pollutant at the concentration equal to that specified by Louisiana's WQC, for an exposure period equal to twelve hours. On the other hand, state WWC with a criterion-concentration equal to, or greater than, that of the corresponding EPA WQC would definitely provide less protection than the EPA criterion. See Appendix C for a listing of various combinations of higher and lower concentrations, shorter and longer durations, and lower and higher frequencies as to their relative degree of protection.

[64] Ibid

[65] See discussion of duration and frequency for toxics in Section D(3) and D(4) above.

Another consideration with regard to aquatic life WQC is that there could be state-specific, watershed-specific, or even waterbody-specific reasons (differences in water column chemistry, temperature, stream flow patterns, resident species of aquatic life) that a state criterion can have a criterion-concentration higher or lower than that for the corresponding EPA criterion and still provide aquatic life protection equal to that for which the EPA WQC was designed. This would not, however, mean that the two criteria would provide equal levels of protection to the relevant use. If, for example, a state's criterion-concentration were higher than EPA's, while the duration and frequency for the two WQC were identical, then the state's criteria would provide a lower degree of protection relative to that which would be provided by adoption of EPA's criterion as a state WQS for the waterbody in question. Nevertheless, site-specific conditions could have resulted in EPA's WQC providing an even higher level of protection than that for which EPA designed it. The effect of the state's higher criterion-concentration would be to bring the level of protection back down to that intended by EPA. Aside from adjusting its aquatic life WQC for metals for hardness, as does EPA, Louisiana's WQS regulations reflect no effort to develop waterbody-specific aquatic life WQC.

As to the degree of protection provided by Louisiana's WQC for toxics pertaining to human health protection, as previously noted, lack of clarity regarding any of the three elements of a numeric water quality criteria makes judgments about the relative level of protection provided by one criterion versus another impossible. This is doubly true with regard to Louisiana and EPA's criteria for 1) consumption of fish and other aquatic organisms (state: Human Health: Non-Drinking Water Supply; EPA: Human Health: Organisms Only), and 2) consumption of fish/other aquatic organisms and drinking water (state: Human Health: Drinking Water Supply; Human Health: Non-Drinking Water Supply), because neither Louisiana nor the federal agency have clearly specified criterion-durations or criterion-frequencies. Since any attempt to discern the relative protectivity of a state verses EPA WQC would require making assumptions about the criterion-durations and criterion-frequencies for each of the two WQC, whatever would be said about level of protection would inherently be burdened by uncertainty.

Nevertheless, if one assumes that the state and EPA for a given pollutant have identical criterion-durations and identical criterion-frequency, whatever each of those might be, then comparison of the state and EPA criterion-concentrations would be indicative of the relative degree of protection provided. Hence, the 32 Louisiana Human Health: Non-Drinking Water Supply WQC for toxics with criterion-concentrations lower than that of the EPA HHWO criteria would provide more protection to people who consume fish and other aquatic life taken from a waterbody in the state than would the EPA criterion; while the five state WQC with a criterion-concentrations higher than the concentration of the corresponding EPA WQC would provide less protection than the EPA criterion. Turning to Louisiana's Human Health: Public Water Supply criteria, the 31 criteria with state WQC having criterion-concentrations lower than the EPA WQC would provide a higher level of protection than the federal agency's HHWO criterion; the two WQC with identical state and EPA criterion-concentrations would provide the same level of protection; and the eight state WQC with a higher criterion-concentration than EPA's WQC would offer a lower degree of protection. Of course, if one made different assumptions that led to the state criterion-duration and/or criterion-frequency being different from those in the corresponding EPA WQC, then a one would draw a different conclusion about the relative degree of protection provided by a given state criterion verses the corresponding EPA WQC. Appendix C has tables showing how different combinations of relative criterion-concentrations, criterion-durations, and criterion- frequencies result in different relative degrees of protection.

It is also important to note that there could be, however, state-specific, watershed-specific, or even waterbody-specific reasons such that a Louisiana Human Health: Non Drinking Water Supply criterion[66] or a Human Health: Drinking Water Supply WQC[67] with a criterion-concentration higher or lower than that for the corresponding EPA criterion could still be equally protective of human consumers of fish from a given waterbody. The most likely reason for such a situation is that the rate of consumption of fish from one or more of the state's waters is either higher or lower than the rate assumed in the methodology EPA used (17.5 grams/day) to develop its recommended default criteria for all waters in the United States. In fact, in calculating its human health WQC, Louisiana does assume a slightly higher fish consumption rate of 20.0 grams/day. This is the likely explanation for the fact that most of Louisiana's WQC applicable to fish consumption and water-based recreation have lower criterion-concentrations than the roughly corresponding EPA HHO criteria, particularly those human health criteria for bioaccumulative pollutants such as DDD, DDE, DDT, aldrin, chlordane, dieldrin, gamma-BHC (lindane), heptachlor, heptachlor epoxide, hexachlorobenzene, hexachlorobutadiene, PCBs, and toxaphene. In contrast, it is harder to surmise a reason for the state's fish consumption criteria having higher criterion-concentrations than those in the corresponding EPA criteria for dioxin, endrin, and toluene, which are also bioaccumulators.

Also, though Louisiana's two sets of human health WQC do take into account the fact that the statewide fish consumption rate is higher than the nationwide rate used by EPA, there is no evidence in the state's WQS regulations of the state having developed sub-state regional, watershed or waterbody specific criteria for toxics, in order to account for different fish consumption patterns within the state. That is, for a given pollutant, there is only one Human Health: Non-Drinking Water Supply and one Human Health: Drinking Water Supply criterion for the entire state, even for highly bioaccumulative pollutants, for which such geographic differentiation would be most germane.

Finally, returning to the problem of the lack of clearly-stated criterion-durations and criterion-frequencies, this not only complicates efforts to determine relative degree of protection provided by one WQC as compared to another, but also can result in lack of consistency in the application of Clean Water Act programs that are driven by water quality criteria. For instance, if one assumes that the criterion-duration for Louisiana's Human Health: Drinking Water Supply criteria is an instant and the criterion-frequency is zero, then any waterbody from which just one valid (meets QA/QC requirements/guidelines) grab sample, out of several such samples, with a concentration of a pollutant higher than the criterion-concentration should be included in the state's Section 303(d) list. On the other hand, if the criterion-duration the criteria were 365 days, then exceedence of WQC would not be indicated by having just one sample out of a number collected over any 365 day period with a concentration above the criterion-concentration. In this latter case, the appropriate determinant of criterion exceedence would be having a set of samples collected over some 365 day periods with an average concentration higher than the criterion-concentration (assuming the criterion-frequency is zero).

[66] Though fish consumption is not mentioned in the title of this set of WQC, they do actually address this mode of human ingestion of toxics, along with water contact recreation.

[67] Though fish consumption is not mentioned in the title of this set of WQC, they do actually address this mode of human ingestion of toxics, along water contact recreation and drinking water supply.

Appendix A

Missing and Extra Criteria for Conventional Pollutants: Louisiana

Table 1 - Aquatic Life

i) MISSING[68] POLLUTANTS

	ACUTE	CHRONIC
fresh water aquatic life	ammonia calcium carbonate chloride (suspended) solids[69]	ammonia calcium carbonate chlorophyll a dissolved gases hydrogen sulfide nitrogen (total) phosphorous (tot.) turbidity (Secchi)[70]
coastal/marine aquatic life	---	---

ii) EXTRA[71] POLLUTANTS

	ACUTE	CHRONIC
fresh water aquatic life	temperature	(total dissolved) solids[72] pH[73] sulfate[5] temperature[6]

[68] "Missing" means those pollutants for which EPA has issued WQC while the state has neither adopted nor officially proposed corresponding criteria. In situations where a state has adopted and submitted to EPA a set of state-adopted changes but EPA has either not acted on the changes or has disapproved the changes, this fact is noted in this document.

[69] EPA criteria are quasi-numeric (expressed in terms of a certain change from background conditions, rather than a specified single value); Louisiana has none.

[70] Louisiana does have chronic turbidity criteria applicable to all waters, expressed as NTUs.

[71] "Extra" means those pollutants for which the state has either adopted or officially proposed a WQC for a given use, while EPA has not published a criterion for this pollutant/use combination.

[72] Louisiana has "default" chronic criteria that apply to all waterbody types, regardless of DU(s); but it also has site-specific criteria for this parameter for a number of waterbodies (Table 3 in the WQS regulations).

[73] Louisiana has one quasi-numeric criterion for this parameter, which could be taken as an acute and/or chronic criterion. Since the state has an acute criterion for the parameter, we have treated the quasi-numeric criterion as chronic.

ii) EXTRA POLLUTANTS: Aquatic Life (cont.)

	ACUTE	CHRONIC
coastal/marine aquatic life	(dissolved) oxygen temperature	chlorides[5] (total dissolved) solids[5] temperature[74] turbidity (NTU)

Table 2 - Drinking Water Supply[75]

MISSING POLLUTANTS

ACUTE	CHRONIC
fecal coliform[76]	chloride color foaming agents odor pH (total dissolved) solids sulfate

ii) EXTRA POLLUTANTS

ACUTE	CHRONIC
specific conductance	fecal coliform[77]

[74] Louisiana has one quasi-numeric criterion for this parameter, which could be taken as an acute and/or chronic criterion. Since the state has an acute criterion for the parameter, we have treated the quasi-numeric criterion as chronic

[75] EPA lacks actual drinking water supply criteria for conventional pollutants – specification of the levels of contaminants in surface waters being used as a raw water supply by public drinking water systems. The only EPA standards with regard to ensuring safe levels of contaminants in drinking water apply to "finished" water – that which results from raw water being passed through a treatment system aimed at removing contaminants to the degree practicable.

[76] Louisiana's Drinking Water Supply WQC for bacteria is "no more than 30 percent of the total samples collected on a monthly basis shall exceed a fecal coliform density of 2,000/100 ml." Because 30% of 30 days is nine days, it seems appropriate to categorize this as a chronic, rather than an acute criterion. EPA's MCL for total coliform bacteria is "no detection in more than 5% of samples" (of finished drinking water), which is more reflective of acute exposure than is Louisiana's WQC. Hence, the table shows the state lacking an acute bacterial criterion for drinking water supply, but having an "extra" chronic criterion.

Table 3 - Water-Based Recreation

i) MISSING POLLUTANTS

	ACUTE	CHRONIC
fresh water	---	Fecal coliform *E. coli* Enterococci
coastal/marine	---	(Enterococci)[78]

ii) EXTRA POLLUTANTS

	ACUTE	CHRONIC
fresh/coastal/marine	---	---

[78] A criterion applicable to Louisiana coastal waters has been promulgated by EPA, but no such WQC currently appears in the state's regulations.

Appendix B

Table 1

	Aquatic Life Protection - Freshwater		Aquatic Life Protection - Marine Water	
	Acute	*Chronic*	*Acute*	*Chronic*
MISSING POLLUTANTS: Pollutants for which Louisiana has adopted a WQC for a given use and for which EPA has not published a corresponding WQC	alpha-Endosulfan Aluminum beta-Endosulfan Chlorine Chloropyrifos Diazinon Heptachlor Epoxide Nonylphenol Parathion Pentachlorophenol Selenium Silver Tributyltin	alpha-Endosulfan Aluminum beta-Endosulfan Demeton Diazinon Guthion Heptachlor Epoxide Iron Malathion Methoxychlor Mirex Nonylphenol Parathion Pentachlorophenol Selenium Tributyltin Chlorpyrifos	alpha-Endosulfan beta-Endosulfan Chlorine Chloropyrifos Diazinon Heptachlor Epoxide Nonylphenol Pentachlorophenol Selenium Silver Tributyltin	alpha-Endosulfan beta-Endosulfan Chlorine Chlorpyrifos Cyanide Demeton Diazinon Di-n-Butyl Phthalate Guthion Heptachlor Epoxide Malathion Manganese Methoxychlor Mirex Nonylphenol Pentachlorophenol Selenium Tributyltin
Total # of Pollutants	13	17	11	18

Table 2

	Human Health Protection - Drinking Water Supply[79]		
MISSING POLLUTANTS: Pollutants for which Louisiana has adopted a WQC for a given use and for which EPA has not published a corresponding WQC	1,2,4-Trichlorobenzene 1,2-Dichlorobenzene 1,2-Dichloropropane 1,2-Diphenylhydrazine 1,2-Trans-Dichloroethylene 1,3-Dichlorobenzene 1,4-Dichlorobenzene 2,4,6-Trichlorophenol 2,4-Dimethylphenol 2,4-Dinitrophenol 2,4-Dinitrotoluene 2-Chloronaphthalene 2-Methyl-4,6-Dinitrophenol 3,3'-Dichlorobenzidine Acenaphthene Acrolein Acrylonitrile alpha-BHC alpha-Endosulfan Anthracene Antimony Asbestos Barium Benzo(a)Anthracene Benzo(a)Pyrene	Benzo(b)Fluoranthene Benzo(k)Fluoranthene beta-BHC beta-Endosulfan Bis(2-Chloroethyl)Ether Bis(2-Chloroisopropyl)Ether Bis(2-Ethylhexyl)Phthalate Butylbenzyl Phthalate Chlorobenzene Chrysene Dibenzo(a,h)Anthracene Diethyl Phthalate Dimethyl Phthalate Di-n-Butyl Phthalate Dinitrophenols Endosulfan Sulfate Endrin Aldehyde Ether, Bis(Chloromethyl) Fluoranthene Fluorene Heptachlor Epoxide Hexachlorocyclo-hexane-Technical Hexachlorocyclopentadiene Hexachloroethane Ideno(1,2,3-cd)Pyrene	Iron Isophorone Manganese Methoxychlor Methyl Bromide Nickel Nitrates Nitrobenzene Nitrosamines Nitrosodibutylamine,N Nitrosodiethylamine,N Nitrosopyrrolidine,N N-Nitrosodimethylamine N-Nitrosodi-n-Propylamine N-Nitrosodiphenylamine Pentachlorobenzene Pentachlorophenol Pyrene Selenium Tetrachlorobenzene,1,2,4,5- Thallium Trichlorophenol,2,4,5-
Total # of Pollutants	72		

[79] Pollutants for which criteria were adopted for this designated use by the state are compared to the list of pollutants for which the EPA has issued human health criteria for consumption of water and aquatic organisms (HHWO).

Table 3

	Human Health Protection - Non-Drinking Water Supply[80]		
MISSING POLLUTANTS: Pollutants for which Louisiana has adopted a WQC and for which EPA has not published a corresponding WQC	1,2,4-Trichlorobenzene 1,2-Dichlorobenzene 1,2-Dichloropropane 1,2-Diphenylhydrazine 1,2-Trans-Dichloroethylene 1,3-Dichlorobenzene 1,4-Dichlorobenzene 2,4,6-Trichlorophenol 2,4-Dimethylphenol 2,4-Dinitrophenol 2,4-Dinitrotoluene 2-Chloronaphthalene 2-Methyl-4,6-Dinitrophenol 3,3'-Dichlorobenzidine Acenaphthene Acrolein Acrylonitrile alpha-BHC alpha-Endosulfan Anthracene Antimony Arsenic Benzo(a)Anthracene Benzo(b)Fluoranthene	Benzo(a)Pyrene Benzo(k)Fluoranthene beta-BHC beta-Endosulfan Bis(2-Chloroethyl)Ether Bis(2-Chloroisopropyl)Ether Bis(2-Ethylhexyl)Phthalate Butylbenzyl Phthalate Chlorobenzene Chrysene Dibenzo(a,h)Anthracene Diethyl Phthalate Dimethyl Phthalate Di-n-Butyl Phthalate Dinitrophenols Endosulfan Sulfate Endrin Aldehyde Ether, Bis(Chloromethyl) Fluoranthene Fluorene Heptachlor Epoxide Hexachlorocyclo-hexane-Technical Hexachlorocyclopentadiene Hexachloroethane	Ideno(1,2,3-cd)Pyrene Isophorone Methyl Bromide Methylmercury Nickel Nitrobenzene Nitrosamines Nitrosodibutylamine,N Nitrosodiethylamine,N Nitrosopyrrolidine,N N-Nitrosodimethylamine N-Nitrosodi-n-Propylamine N-Nitrosodiphenylamine Pentachlorobenzene Pentachlorophenol Pyrene Selenium Tetrachlorobenzene,1,2,4,5- Thallium Trichlorophenol,2,4,5-
Total # of Pollutants	69		

[80] Pollutants for which criteria were adopted for this designated use by the state are compared to the list of pollutants for which the EPA has issued human health criteria for consumption of aquatic organisms only (HHO).

Table 4

	Aquatic Life Protection - Freshwater		Aquatic Life Protection - Marine Water	
	Acute	*Chronic*	*Acute*	*Chronic*
EXTRA POLLUTANTS: Pollutants for which EPA has adopted a WQC and for which Louisiana has not published a corresponding WQC	1,1,1-Trichloroethane 1,1,2,2-Tetrachloroethane 1,1,2-Trichloroethane 1,1-Dichloroethylene 1,2-Dichloroethane 1,3-Dichloropropene 2,4-Dichlorophenol 2-Chlorophenol 4,4'-DDD 4,4'-DDE 4-Chlorophenol Benzene Benzidine Bromoform Carbon Tetrachloride Chloroform Endosulfan Ethylbenzene Hexachlorobutadiene Methyl chloride Methylene chloride PCBs (total) Phenol Tetrachloroethylene Toluene Trichloroethylene	1,1,1-Trichloroethane 1,1,2,2-Tetrachloroethane 1,1,2-Trichloroethane 1,1-Dichloroethylene 1,2-Dichloroethane 1,3-Dichloropropene 2,4-Dichlorophenol 2-Chlorophenol 4,4'-DDD 4,4'-DDE 4-Chlorophenol Benzene Benzidine Bromoform Carbon Tetrachloride Chloroform Endosulfan Ethylbenzene gamma-BHC Hexachlorobutadiene Methyl chloride Methylene chloride Phenol Tetrachloroethylene Toluene Trichloroethylene	1,1,1-Trichloroethane 1,1,2,2-Tetrachloroethane 1,1,2-Trichloroethane 1,1-Dichloroethylene 1,2-Dichloroethane 1,3-Dichloropropene 4,4'-DDD 4,4'-DDE Benzene Bromoform Carbon Tetrachloride Chloroform Chromium (III) Endosulfan Ethylbenzene Hexachlorobutadiene Methyl chloride Methylene chloride PCBs (total) Phenol Tetrachloroethylene Toluene Trichloroethylene	1,1,1-Trichloroethane 1,1,2,2-Tetrachloroethane 1,1,2-Trichloroethane 1,1-Dichloroethylene 1,2-Dichloroethane 1,3-Dichloropropene 4,4'-DDD 4,4'-DDE Benzene Bromoform Carbon Tetrachloride Chloroform Chromium (III) Endosulfan Ethylbenzene Hexachlorobutadiene Methyl chloride Methylene chloride Phenol Tetrachloroethylene Toluene Trichloroethylene
Total # of Pollutants	26	26	23	22

Table 5

Human Health Protection		
	Drinking Water Supply	*Non-Drinking Water Supply*
EXTRA POLLUTANTS: Pollutants for which EPA has adopted a WQC and for which Louisiana has not published a corresponding WQC	1,1,1-Trichloroethane 2,3-Dichlorophenol 2,5-Dichlorophenol 2,6-Dichlorophenol 3,4-Dichlorophenol 3-Chlorophenol 4-Chlorophenol Cadmium Chromium (III) Chromium (VI) Endosulfan Lead Mercury	2,4,5-TP (Silvex) 2,4-D Endosulfan Hexachloro-1,3-butadiene
Total # of Pollutants	13	6

Table 6

	Human Health		Aquatic Life Protection - Fresh Water		Aquatic Life Protection – Marine Water	
	Drinking Water Supply[81]	*Non-Drinking Water Supply*[82]	*Acute*	*Chronic*	*Acute*	*Chronic*
Pollutants with a state criterion-concentration **higher** than the criterion-concentration in the corresponding EPA criteria	Dioxin Arsenic Cyanide Endrin Ethylbenzene Toluene Trichloroethylene	Dioxin Cyanide Endrin Ethylbenzene Toluene	Cadmium Copper Cyanide Endrin gamma-BHC Mercury Nickel	Cadmium Chromium (III) Copper Cyanide Endrin Nickel Toxaphene	Cadmium Mercury	Cadmium Copper

[81] The state criterion-concentrations in the criteria covering the set pollutants under this designated use were compared to the criterion-concentrations in EPA's Human Health: Water and Organisms criteria.

[82] The state criterion-concentrations in the criteria covering the set pollutants under this designated use were compared to the criterion-concentrations in EPA's Human Health: Organisms Only criteria.

Table 7

	Human Health		Aquatic Life Protection - Fresh Water		Aquatic Life Protection – Salt Water	
	Drinking Water Supply[83]	*Non-Drinking Water Supply*[84]	*Acute*	*Chronic*	*Acute*	*Chronic*
Pollutants with a state criterion-concentration **lower** than the criterion-concentration in the corresponding EPA criteria	1,1,2,2-Tetrachloroethane 1,1,2-Trichloroethane 1,1-Dichloroethylene 1,2-Dichloroethane 1,3-Dichloropropene 2,4-Dichlorophenol 2-Chlorophenol 4,4'-DDD 4,4'-DDE 4,4'-DDT Aldrin Benzene Benzidine Bromoform Carbon Tetrachloride Chlordane Chloroform Copper Dichlorobromomethane Dieldrin gamma-BHC Heptachlor Hexachlorobenzene Hexachlorobutadiene Methylene Chloride PCBs Phenol Tetrachloroethylene Toxaphene Vinyl Chloride Zinc	1,1,2,2-Tetrachloroethane 1,1,2-Trichloroethane 1,1-Dichloroethylene 1,2-Dichloroethane 1,3-Dichloropropene 2,4-Dichlorophenol 2-Chlorophenol 4,4'-DDD 4,4'-DDE 4,4'-DDT Aldrin Benzene Benzidine Bromoform Carbon Tetrachloride Chlordane Chlorodibromomethane Chloroform Dichlorobromomethane Dieldrin gamma-BHC Heptachlor Hexachlorobenzene Hexachlorobutadiene Methylene Chloride Polychlorinated Biphenyls PCBs Phenol Tetrachloroethylene Toxaphene Trichloroethylene Vinyl Chloride Zinc	Arsenic Chromium (III) Dieldrin Lead Zinc	Dieldrin Mercury Zinc	Copper Lead	Lead Mercury
Total # of Pollutants	31	32	5	3	2	2

[83] The state criterion-concentrations in the criteria covering the set pollutants under this designated use were compared to the criterion-concentrations in EPA's Human Health: Water and Organisms criteria.
[84] The state criterion-concentrations in the criteria covering the set pollutants under this designated use were compared to the criterion-concentrations in EPA's Human Health: Organisms Only criteria.

Appendix C

SITUATIONS IN WHICH STATE WQC ARE CLEARLY LESS PROTECTIVE THAN EQUIVALENT EPA WQC

	Concentration	Duration	Frequency
State vs. EPA[i]	**higher**	**longer**	**higher**
" " "	equal	**longer**	**higher**
" " "	**higher**	equal	**higher**
" " "	**higher**	**longer**	equal
" " "	**higher**	equal	equal
" " "	equal	equal	**higher**
" " "	equal	**longer**	equal

SITUATIONS IN WHICH STATE WQC ARE CLEARLY MORE PROTECTIVE THAN EQUIVALENT EPA WQC

	Concentration	Duration	Frequency
State vs. EPA	**lower**	**shorter**	**lower**
" " "	equal	**shorter**	**lower**
" " "	lower	equal	**lower**
" " "	**lower**	**shorter**	equal
" " "	**lower**	equal	equal
" " "	equal	equal	**lower**
" " "	equal	**shorter**	equal

SITUATIONS IN WHICH COMPARATIVE LEVEL OF PROTECTION CANNOT BE DETERMINED BY SIMPLY LOOKING AT THE TWO CRITERIA

	Concentration	Duration	Frequency
State vs. EPA	**lower**	**shorter**	**higher**
" " "	equal	**shorter**	**higher**
" " "	**lower**	equal	**higher**
" " "	**lower**	**longer**	equal
" " "	**higher**	equal	**lower**
" " "	**higher**	**shorter**	equal
" " "	equal	**longer**	**lower**

[i] The state WQC's component (e.g. duration) compared to the component for corresponding EPA WQC.

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