Fiscal Note

Rule Citation Number: 15A NCAC 02B, Sections .0201 - .0206, .0208, .0211 - .0212, .0214-.0216, .0218 - .0228, .0230 -.0231

Rule Topic: Revision of Rules 02B Classifications and Water Quality Standards Applicable to Surface Waters and Wetlands of North Carolina, and Triennial Review Amendments for Fresh Surface Water Quality Standards for Class C Waters, and for Tidal Salt Water Quality Standards for Class SC Waters

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Impact Summary:

State government:	No
Local government:	Yes
Private entities:	Yes
Substantial Impact:	Yes
Federal government:	No

Necessity: N.C. General Statute(G.S.) §150B-21.3A *requires* state agencies to review existing rules every 10 years, determine which rules are still necessary, and either re-adopt or repeal each rule as appropriate. The proposed rulemaking satisfies these requirements for a portion of the Department's rules. For the amendments to the Triennial Review, the proposed rule amendments are based upon review of the surface water quality standards and classifications in accordance with the Clean Water Act Section 303(c)(1) and State of North Carolina regulations in 15A NCAC 02B. Several numerical concentrations and narrative rule changes are proposed to meet national guidance and establish allowable concentrations of pollutants that protect public health and aquatic life. The Division of Water Resources (DWR) North Carolina Department of Environmental Quality (NC DEQ) received the approval of the Water Quality Committee (WQC) of the Environmental Management Commission (EMC) in January 2018, and approval from EMC in March 2018, to proceed to notice and public hearing.

1. Summary

Necessity of the 02B Water Quality Standards Applicable to Surface Waters and Wetlands:

Heavy metal pollution in water and aquatic organisms needs monitoring and surveillance because many heavy metal ions are known to be toxic or carcinogenic. Heavy metals are not biodegradable and tend to accumulate in living organisms; accumulation in fish, oysters, mussels, sediments and other components of aquatic ecosystems have been reported from all over the world (Shafiquzzaman et all, 2015). Because these elements do not biodegrade, they can be transmitted to humans directly or through the food chain. In view of the toxicological effects of heavy metals on the environment, animals and human beings, it becomes imperative to treat these toxic compounds in wastewater effluents before they are discharged into freshwater bodies.[1]

Proposed Rule Changes:

The Division of Water Resources reviewed its Classifications and Water Quality Standards Applicable to Surface Waters and Wetlands of North Carolina Rules, 15A NCAC 02B.0201 - .0206, .0208, .0211 - .0212, .0214-.0216, .0218 - .0228, .0230 -.0231, in accordance with G.S. §150B-21.3A and proposes to re-adopt all of the rules. As part of the review process, the Division identified necessary changes in some of these rules, including:

1. Correction of agency names and addresses;
2. Correction of cross-references and other regulatory citations;
3. Correction of spelling and typographical errors;
4. Necessary clarifications;
5. Change in the state's surface water quality standards (numerical concentrations and narrative standards) in order to meet national guidance and establish allowable concentrations of pollutants that protect public health and aquatic life;
6. Removal or modification of provisions superseded by statutes and session laws;
7. Removal of components deemed not necessary; and
8. Relocation of some program components into other rules.

The proposed changes to the water quality standards are driven by different requirements and go beyond the readoption of these rules. The standards for several metals will result in lower numeric standards for the surface waters into which a considerable number of wastewater treatment facilities discharge. The lower standards will, in turn, result in more stringent discharge limitations for many of those facilities, and some will have to invest in additional treatment units or other control measures in order to comply.

The revised aquatic life-based metals standards are designed to prevent further water quality degradation and improve the quality of waters with high metals concentrations by reducing metals inputs to surface waters. The proposed rules are expected to accomplish these goals by establishing a protective instream concentration that is more reflective of the current science on metals toxicity to aquatic life in ambient waters.

[1] See Appendix 2 for additional detail about the toxicological effects of Zinc, Copper, and Silver.

Economic Impact of Proposed Changes:

As measured from the baseline conditions, there are economic costs and economic benefits associated with these proposed rules changes. For some rules, some language is removed or added with an intent to reduce burden to the applicants, while some of the other language revisions have the intent to be consistent with current General Statutes and Rules.

Protection of Water Quality is the main benefit of this rule revision. These regulations serve to protect waterbodies for recreation, fishing, drinking water supplies, shell fishing, and aquatic life propagation and survival.

Costs estimates related to the proposed metals rule changes in 15A NCAC 02B .0211 and .0220 included implementation costs related to disposal of wastewater, biosolids handling, dewatering of sludge, additional staff time associated with analytical sampling, increased costs of chemicals used in a treatment plant, additional analytical laboratory costs, operation and maintenance resources and treatment plant upgrades. The same cannot be applied to 15A NCAC 02B .0224 rule because this one would be based on case by case scenarios, and accordingly with NC DWR past applications, some of the requested reclassifications will have no economic impacts. The readoption and revision of rules 15A NCAC 02B .0211 and .0220 are expected to have significant economic impact, while 15A NCAC 02B .0224 doesn't because it is based on case by case scenario.

Water systems and the wastewater treatment systems go through periodic process of upgrades instead of building new facilities. According to Keith Miller 2012, treatment-plant assets have typical service lives of only 15 years to 50 years. The upgrades of those facilities mean millions of dollars saved from investing in new plants. Upgrades of activated sludge wastewater treatment plants and water treatment plants can typically include measures such as precipitation/flocculation processes, increase of biomass concentration, influent balancing, increase of oxygenation capacity with pure oxygen, increase of the capacity of final clarifiers, achieve water-quality based TRC (Total residual chlorine) and nutrient limits, nutrients removal, pretreatment of industrial effluents, increase the design flow, increase efficiency of water facilities by reducing the amount of energy used by them, replacement of old equipment, updating the filter gallery, membrane filtration system, UV/advanced oxidation and granular activated carbon (GAC) contactors, and upgrades necessary to accommodate anticipated growth.

The proposed rules would affect 90 out of 1100 wastewater treatment plants in total. The Division estimates the associated costs of the proposed changes at $181.8 million over the first 30 years of implementation. The division also assessed the uncertainties inherent in the analysis and estimates that the present value of the 30-year costs could range from as low as $103 million to as high as $256 million.

A reduction in the concentrations of copper, silver, and zinc in the state's aquatic environment is expected to provide a direct ecological benefit to aquatic ecosystems and may indirectly benefit human uses as well; for example, by reducing human exposures to metals via fish consumption or aiding in the recovery of fishery resources.

Although the Division believes these changes will lead to improved surface water quality, it is not possible to determine the absolute improvement in water quality that will result from the rule

changes with the available data. Therefore, the expected benefits of the rules cannot be monetized and compared directly to the estimated costs. The Division relied on economic model from an existing national study, customized to reflect North Carolina, to estimate residents' willingness to pay for water quality improvements (a measure of the societal benefits of such improvements and is further described in Section 3.3). Based on this analysis, the benefits of the proposed rules can be expected to exceed the costs if the rules improve water quality conditions in 0.5% or more of the state's water bodies, or approximately 1,600 acres of lakes and 200 miles of river.

2. Rule History

G.S. §150B-21.3A requires the Department to evaluate each of its existing rules and make an initial determination as to whether the rules are:

Necessary with substantive public interest – the agency has received public comment on the rule within the past two years or the rule affects the property interest of the regulated public, and the agency knows or suspects that any person may object to the rule.

Necessary without substantive public interest – the agency determines that the rule is needed, and the rule has not had public comment in the last two years. This category includes rules that identify information that is readily available to the public, such as an address or telephone number.

Unnecessary – the agency determines that the rule is obsolete, redundant or otherwise not needed.

The Department must then determine which rules are still necessary and propose to re-adopt, with or without modifications, or to repeal each rule as appropriate.

The Division categorized all the subject rules as 'Necessary with substantive public interest.' The Rules Review Commission reviewed and approved these determinations, as did the General Assembly's Joint Legislative Administrative Procedure Oversight Committee (JLAPO), and the Review Process was completed in December 2014.

The Division prepared draft rules for readoption (Subchapters 02B, 02H, 02T, and 02U) and solicited input on the proposed actions from stakeholders in four outreaches meetings in April, 2015 and two more in April, 2017. The meetings gave the stakeholders the opportunity to review the Division's draft rules and an opportunity to submit comments on the proposed rules. The draft rules were posted on the Division's webpage prior to each meeting. Stakeholders voiced and submitted comments to the Division.

Simultaneously on November 13, 2014, the North Carolina Environmental Management Commission (EMC) approved the State of North Carolina 2007-2014 Triennial Review of Water Quality Standards (WQS) rules, and these rules in 2B .0200 became effective for state purposes on January 1, 2015. Section 303(c)(1) of the Clean Water Act (CWA, or the Act) requires States to review and, as needed, modify water quality standards, at least once every three years (amendments to 15A NCAC 02B regulations). In that Triennial Review, NC DWR identified several changes to numerical and narrative standards that were warranted to satisfy the CWA goals and provide a more thorough process for assessing surface water quality. Revisions included updates to standards for some metals, and revision on 2,4-D standards. After the rules

were approved by the EMC, they were submitted to the Environmental Protection Agency (EPA) for approval.

In April 6, 2016, the EPA sent its formal response to DEQ and disapproved the sections of the rules that provided approaches for their implementation. From EPA's letter, "the EPA is disapproving revisions relating to biological confirmation for toxics in assessment and three revisions relating to the implementation of the hardness based equations for metals under the National Pollutant Discharge Elimination Systems (NPDES) permits, including the use of action levels, the use of a low-end hardness cap, and the use of the median of the 8-digit hydrologic unit for determining hardness when developing NPDES permits. These revisions are inconsistent with the requirements of 40 C.F.R. Part 131 and the CWA and therefore, are disapproved."

Repeal of these provisions in the rules will result in the application of more stringent water quality standards for metals and more stringent discharge limitations for a considerable number of wastewater treatment facilities across the state. Those dischargers may have to install additional treatment units, modify existing units, or implement other metals reduction programs in order to comply with the new limits.

Certificate of Federal Requirement. In accordance with requirements outlined in N.C.G.S. §150B-19.1(g), the Division of Water Resources is proposing changes to the Classifications and Water Quality Standards Rules - 15A NCAC 02B. By incorporating those federal changes, the proposed amendments to 15A NCAC 02B .0211 and 15A NCAC 02B .0220 will make the State Water Quality Regulation equivalent to, consistent with, and no less stringent than the federal CWA program. Because the State Classifications and Water Quality Standards Program is federally delegated, EPA continues to exercise oversight, including the ability to revoke program authorization, to ensure consistency with CWA obligations.

3. Economic Impact Analysis

The following tables briefly describe the proposed rule changes and summarize the anticipated impact of each change.

3.1: Subchapter 02B – Surface Water and Wetland Standards

Section .0200 – Classifications and Water Quality Standards Applicable to Surface Waters and Wetlands of North Carolina

Rule	Proposed Change	Source of Change	Economic Impact	Environment Impact
15A NCAC 02B .0201 Antidegradation Policy	Updated reference.	Staff Review	None	None
15A NCAC 02B .0202 Definitions	Revised language for clarity; revised definition; reorganized texts; provided flexibility for sampling under various conditions; moved some definitions to 2B .0621, 2B .0701 and 2B.0104 and 2B .0623(4).	Staff Review and Public Comments	None	None
15A NCAC 02B .0203 Protection of Waters Downstream of Receiving Waters	None	Staff Review	None	None
15A NCAC 02B .0204 Location of Sampling Sites and Mixing Zones	Updated reference.	Staff Review	None	None
15A NCAC 02B .0205 Natural Characteristics Outside Standards Limits	None	Staff Review	None	None
15A NCAC 02B .0206 Flow Design Criteria for Effluent Limitations	Revised language for clarity.	Staff Review	None	None
15A NCAC 02B .0208 Standards for Toxic Substances and Temperature	None	Staff Review	None	None
15A NCAC 02B .0211 Fresh Surface Water Quality Standards for Class C Waters	Action Levels; Biological Confirmation, use of hardness in permitting disapproved by EPA, now changed to comply with its recommendations; Merging usage information from .0101 and .0301 into individual classification rule; and revised language for clarity.	Staff Review and Public Comments, and EPA comments	Yes	Yes

Rule	Proposed Change	Source of Change	Economic Impact	Environment Impact
15A NCAC 02B .0212 Fresh Surface Water Quality Standards for Class WS-I Waters	Merged usage information from .0101 and .0301 into individual classification rule; Rearranged rules; Revised language for clarity; Moved some rules to Water Supply Watershed Protection Rules; Removed duplicative and unnecessary language; and corrected reference.	Staff Review and Public Comments	None	None
15A NCAC 02B .0214 Fresh Surface Water Quality Standards for Class WS-II Waters	Rearranged rules; Revised language for clarity; Moved some rules to Water Supply Watershed Protection Rules; Removed duplicative and unnecessary language; and corrected reference.	Staff Review and Public Comments	None	None
15A NCAC 02B .0215 Fresh Surface Water Quality Standards for Class WS-III Waters	Rearranged rules; Revised language for clarity; Moved some rules to Water Supply Watershed Protection Rules; Removed duplicative and unnecessary language; and corrected reference.	Staff Review and Public Comments	None	None
15A NCAC 02B .0216 Water Supply Watershed Protection Program: Definitions	Rearranged rules; Revised language for clarity; Moved some rules to Water Supply Watershed Protection Rules; Removed duplicative and unnecessary language; and corrected reference.	Staff Review and Public Comments	None	None
15A NCAC 02B .0218 Fresh Surface Water Quality Standards for Class WS-V Waters	Rearranged rules; Revised language for clarity; and Removed duplicative and unnecessary language.	Staff Review and Public Comments	None	None
15A NCAC 02B .0219 Fresh Surface Water Quality Standards for Class B Waters	Rearranged rules; Revised language for clarity; Removed duplicative and unnecessary language; and provided rule reference.	Staff Review and Public Comments	None	None
15A NCAC 02B .0220 Tidal Salt Water Quality Standards for Class SC Waters	Action Levels and Biological Confirmation disapproved by EPA, now changed to comply with its recommendations; Revised language for clarity; Removed duplicative and unnecessary language; and updated reference.	Staff Review and Public Comments and EPA comments	Yes	Yes
15A NCAC 02B .0221 Tidal Salt Water Quality Standards for Class SA Waters	Merged information from .0101, .0108 and .0301; Revised language for clarity; and Deleted unnecessary language.	Staff Review and Public Comments	None	None

Rule	Proposed Change	Source of Change	Economic Impact	Environment Impact
15A NCAC 02B .0222 Tidal Salt Water Quality Standards for Class SB Waters	Merged information from .0101, .0108 and .0301; Revised language for clarity; and Deleted unnecessary language.	Staff Review and Public Comments	None	None
15A NCAC 02B .0223 Nutrient Sensitive Waters	Revised language for clarity and added reference.	Staff Review and Public Comments	None	None
15A NCAC 02B .0224 High Quality Waters	Revised language for clarity; added reference. Nursery areas will require a reclassification proceeding prior to applying HQW classification. The effect is that there will be a requirement for a public process.	Staff Review and Public Comments	None	None
15A NCAC 02B .0225 Outstanding Resource Waters	Revised language for clarity; Updated reference; Updated language for consistency with CWA and other state classifications; and deleted unnecessary language.	Staff Review and Public Comments	None	None
15A NCAC 02B .0226 Exemptions from Surface Water Quality Standards	None	Staff Review	None	None
15A NCAC 02B .0227 Water Quality Management Plans	None	Staff Review	None	None
15A NCAC 02B .0228 Effluent Channels	None	Staff Review	None	None
15A NCAC 02B .0230 Activities Deemed to Comply with Wetland Standards	None	Staff Review and Public Comments	None	None
15A NCAC 02B .0231 Wetland Standards	Merging information from .0101 and .0301 into this rule; Removed unnecessary language; and added a reference for clarity.	Staff Review and Public Comments	None	None

3.2 Costs

The Division of Water Resources has carefully considered the EPA recommendations regarding its 2007-2014 Triennial Review Fiscal Note and proposes to revise the affected rules accordingly. The Division has prepared this economic impact analysis for the proposed rule changes.

As was noted in the 2007-2014 Triennial Review Fiscal Note, changes to surface water quality standards for metals impact some (but not all) wastewater facilities that discharge to surface waters of the state. These wastewater facilities are regulated under the National Pollutant Discharge Elimination System (NPDES) permit program administered in North Carolina by the Division. NPDES permits include effluent limitations that are calculated to ensure that any given discharge does not cause an exceedance of applicable water quality standards in its receiving waters. The circumstances are unique for each discharge, and these water quality-based limits are developed on a case-by-case basis. More stringent surface water standards for metals can result in new effluent limitations in some dischargers' permits or can cause existing limits to become more stringent. Affected facilities can include municipal, industrial, and groundwater remediation facilities, and (drinking) water treatment plants across the state.

The methods used to prepare this 2018 fiscal analysis are much the same as those used for the 2014 analysis. The methods are described briefly below. Readers should refer to the 2014 fiscal note document for a more detailed explanation of the Division's methodology.

Except where noted under the '2018 Methodology' heading below, the current analysis examines the *incremental* impacts of the new metals standards beyond the impacts projected in the 2014 fiscal note.

2014 Methodology and Results

In 2014, the Division estimated the impacts of its rules changes resulting from its 2007-2014 Triennial Review of Water Quality Standards. OSBM approved the resulting fiscal note with some revisions. The 2014 fiscal note concluded that it could cost wastewater dischargers across the state $182 MM (30-year NPV in 2014 dollars, mid-range estimate) to comply with new more stringent metals limits that could result from the standards changes proposed at that time.

To arrive at that estimate, the Division undertook an extensive analysis to determine, first, how many dischargers would likely be impacted by the new metals standards and, second, the potential economic impacts to those dischargers. In 2011, the Division administered 1,250 individual permits for wastewater discharges.

To determine whether a facility will receive a metals limit, Division staff typically conduct a statistical analysis of the facility's discharge monitoring data to determine whether the discharge has a reasonable potential to contravene applicable metals standards. If the Reasonable Potential Analysis (RPA) finds that the maximum value predicted from the effluent data exceeds the maximum allowable value (based on the metals standard and available dilution in the stream), the discharge is said to exhibit 'reasonable potential', and protective limits are included in the permit. If the metal is present at lower, but still significant, concentrations, the facility would not receive a limit but may be required to monitor for the metal.

In 2014, the staff selected 141 of the 1,250 active NPDES permits (approximately 20%) for examination. The permits were first divided into four types: municipal, industrial, groundwater remediation, and water treatment plants. Within each of these, permits were further divided according to size (permitted flow rate), receiving waters (freshwater or saltwater), and other factors, to create subsets of similar permits. Staff performed RPAs for the 141 facilities to determine which facilities' metals requirements would be affected by the new standards and how severely they might be affected. The results varied unpredictably, even within the subsets of similar facilities, illustrating the site-specific nature of the RPAs. Applying the new standards could result in new or more stringent limits for one or more metals, less stringent limits, removal of limits, or changes in monitoring requirements.

The Division considered a discharger to be impacted if it would likely receive one or more new limits for three indicator metals: cadmium, lead, or nickel. The impacts to any given discharger were assumed to be the same regardless of how many new limits it received; that is, it was assumed that actions taken to control one metal would effectively control the other metals as well.

For the four groups of permits, the staff then developed a series of escalating actions that an affected discharger might take in response to new metals requirements in its permit. The actions began with adoption of more rigorous monitoring procedures (lowest impact) and continued to source identification studies, basic metals treatment, and more advanced treatment options (highest impact). The notion was that each facility would continue to take action, step-wise, until it complied with its new requirements. Success rates at each step were assumed, and total number of each action was estimated. Unit costs were developed for each type of action. The numbers of actions were combined with the unit costs to produce cost estimates for each subset of permits, and the results were then extrapolated to the universe of 1,250 permitted dischargers.

Subtotal costs were calculated and reported for the four discharger groups. The process and results are summarized below:

Municipal or Local Government Impacts

The staff evaluated 61 Publicly Owned Treatment Works (POTWs) that represented various subcategories of the 292 POTWs in the state; for example, large/ small, with/ without industrial pretreatment, with/ without metals limits, fresh/ salt receiving stream. The staff conducted RPAs to determine which dischargers were likely to cause instream exceedances of the standards for cadmium(Cd), lead (Pb), and nickel(Ni), thus requiring limits for one or more of those metals. They extrapolated the results from these 61 facilities to the full set of 292. (Staff evaluated copper (Cu), silver(Ag), and zinc (Zn) at that time but did not include those results in the cost analyses due to the "Action Level" policy.) The estimated impact of the changes to the Cd, Pb, and Ni standards to POTWs was $150 million (30-year Net Present Value-NPV, 2014 dollars, mid-range estimate), or 83% of the total impact to point sources.

Industrial Impacts

Industrial facilities were divided into five subcategories: metal finishing/ forming, steam electric power generation, chemicals manufacturing, textiles manufacturing, and assorted other facilities. Another 160 facilities are not considered significant sources of metals and were not considered in the analysis.

As with the POTW analysis, staff selected representative facilities in each subcategory, a total of 23 of the 65 facilities in the state subject to metals limits. Six of the 23 appeared to be impacted in 2014, and it was assumed each would install chemical precipitation units to comply with metals limits. The estimated impact for the group was $20 million (30-year NPV, 2014 dollars, mid-range estimate), or 11% of the total point source impacts.

Groundwater Remediation Impacts

The 2014 analysis focused on groundwater remediation sites with leaded petroleum product contamination. The action level metals (Cu, Ag, Zn) were also evaluated at that time but their impacts were not considered due to the Action Level policy. Currently, 10 of 39 individual permits have monitoring requirements (and 3 have permit limits).

With input from the Division of Waste Management, the staff determined that sites receiving new limits for lead would likely install zeolite-based filtration units to comply with those limits. DWM provided cost information for those units. The estimated impact for this group was $9.6 million (30-year NPV, 2014 dollars, mid-range estimate).

Water Treatment Plant (WTP) Impacts

In 2014 values, it was estimated that 11 of 43 WTPs would be impacted by the revised standards. The action level metals (Cu, Ag, Zn) were also evaluated at that time but their impacts were not considered due to the Action Level policy. The plants were of four types, based on the treatment process utilized: conventional filtration, ion exchange, membrane/ reverse osmosis, and greensand filtration. It was assumed that most of the plants would install supplemental filtration of their discharges. The estimated impact for this group was $2.3 million (30-year NPV, 2014 dollars, mid-range estimate).

The methodologies and working assumptions used in the 2014 analyses, and the results of those analyses, are described in greater detail in the Division's 2007-2014 Triennial Review fiscal note.

The estimated impacts (costs + savings) presented in the 2007-2014 Triennial Review Fiscal Note were as follows (30-year NPV, 2014 dollars, mid-range estimate) assuming 2% annual inflation rate and 7% annual interest rate):

Estimated Impacts, 2014 Metals Standards

Category	2014 Costs in 2014 Dollars ($MM)
Municipal (POTWs)	$150.3
Industrial	$19.6
Groundwater Remediation	$9.6
WTPs	$2.3
Total	$181.9

2018 Methodology and Results

The Division has limited this second analysis to an evaluation of impacts to municipal facilities (POTWs) discharging to fresh waters. The rationale is that:

- The 2014 analysis indicated that 85% of the estimated impacts would be borne by POTWs.
- Since 2011 (the baseline year for the 2014 analysis), the total number of permits has decreased from 1,250 to approximately 1,100, meaning that there are fewer active facilities to be impacted by the proposed standards for copper, silver, and zinc. See table below.

Numbers of Individual NPDES Wastewater Permits

Wastewater Permit Category	Number of Permits	
	2011	2018
Municipal WWTP [1] (POTWs)	292	280
100% Domestic < 1 MGD WWTP	474	413
Commercial & Industrial WWTP	225	205
Groundwater Remediation	38	33
Water Treatment Plants (WTP)	221	183
Total	1,250	1,114

- The number of POTWs' permits has decreased by 4%, while the numbers of other groups' permits have decreased by 12-17%. Thus, the POTWs' share of the impacts has increased.
- A significant number of industrial facilities are already subject to permit limits for the "action level" metals under federal guidelines, meaning that only a small number would likely be affected by the 2018 rules changes.
- At the same time, the Division is assuming that all of the 1,250 original permits are still active, thus overestimating the impacts of the current rule changes. This should offset any additional impacts that might be projected for industrial, groundwater remediation, or water treatment plant facilities, especially given the reduced numbers of those facilities.
- Re-assessing how many permits in each of the multiple subsets would potentially be impacted would require considerable staff time to complete and would have little effect on the final results of the analysis.

The Division believes that this approach results in a fiscally conservative estimate of the impacts to wastewater discharges as a whole.

Municipal or Local Government Impacts

The Division used the same methodologies and assumptions as in 2014 to evaluate the impacts of the rule changes on POTWs, except that it considered impacts of the new standards for copper, silver, and zinc as well as those for cadmium, lead, or nickel. The same permits and

subsets of POTW permits were evaluated, and the 'reasonable potential' analyses were conducted using the same effluent data. In general, the characteristics of the facilities' discharges and receiving streams are not expected to have changed significantly since the 2014 analysis (implementation of the 2014 standards is only getting underway, so changes in the data will not be apparent for several more years).

For the 2018 analysis, the staff considered a POTW to be impacted if it currently had no limits for any of the six 'target' metals and was now projected to receive one or more limits for copper, silver, or zinc. A discharger that was considered impacted for cadmium, lead, or nickel in 2014 and would now receive new limits for copper, silver, or zinc was not considered to be impacted a second time: actions taken to comply with the first metals limits were assumed to also be effective for the added metals.

Additional rule provisions. The EPA disapproved proposed language in the 2014 rules that would have set a minimum hardness value to be used when applying the new hardness-dependent metals standards. The Division expects that, in the implementation of the standards, a hardness floor will be applied in the permitting program. The biological confirmation provision of the rules is closely related to the action level policy; both were disapproved and are addressed through the current proposed rule changes and in this fiscal analysis.

The following table shows the numbers of POTWs predicted to be impacted in the 2014 analysis and in this 2018 analysis.

Numbers of POTWs Impacted – 2014 and 2018

	Numbers of Permits Affected by New Metals Standards	
Projected Outcome	**Cd, Pb, Ni (2014)**	**Cd, Pb, Ni, Cu, Ag, Zn (2018)**
No impact - continue 'no requirements' or 'Mon. Only'	227	142
Indefinite - need better data - Level I controls	9	8
More stringent, marginal RP - Level II controls	9	33
More stringent - Level III controls	41	107
Less stringent - revert to 'Monitor Only'	6	2
Total	**292**	**292**

Levels I, II, and III represent metals control strategies of increasing complexity and cost. The wastewater chapter of the 2014 report explains each in detail.

When Cu, Ag, and Zn standards are applied, 90 more POTWs are expected to receive new permit limits for metals (Levels II and II) than in 2014.

Staff calculated the combined impacts of the new standards for all six metals, using the same methods and working assumptions as in 2014. As before, staff assumed a 7% per annum discount rate. A 2% per annum inflation rate was assumed except that the *Engineering News*

Record Construction Cost Index was used to gauge inflation for capital projects. The Index was updated to the most recent value available (December 2017). The results were expressed as 30-year NPVs in 2017 dollars, with a starting date of December 2017.

The staff then updated the 2014 calculations, converting the estimated impacts to 2017 dollars. Results were also expressed as the 30-year NPV and, because implementation of the 2014 standards is just beginning, the same December 2017 start date was used.

The differences between the two sets of results represent the incremental impacts of the new standards on the wastewater discharges. The estimates from each step of the calculations, for each discharger group, are summarized in the table below.

As noted under the '2018 Methodology and Results' heading, above, the Division focused its analysis on impacts to municipal dischargers; and staff included impacts for 12 POTWs that have ceased discharge since the 2014 analysis and assumed that those added impacts would be sufficient to offset any impacts in the industrial, groundwater remediation, or water treatment plant categories.

The final result is that the estimated incremental impacts to the NPDES wastewater dischargers range from $103 million and $256 million with a mid-range estimate of $182 million (all values as 30-year NPV, 2017 dollars).

Calculation of Incremental Impacts – Mid-Range Estimates

		(A)	(B)	(C)
Category	**2014 Costs in 2014 Dollars ($MM) [1]**	**2014 Costs in 2017 Dollars ($MM)**	**2017 Costs in 2017 Dollars ($MM)**	**Difference 2014-2017 Analyses**
Municipal	$150.3	$162.2	$344.0	$181.8
Industrial	$19.6	$20.6	$20.6	$0
GW Remediation	$9.6	$9.7	$9.7	$0
WTPs	$2.3	$2.5	$2.5	$0
Total	$181.9	$194.9	$376.7	$181.8

Column B – Column A = Column C, incremental impacts

[1] Values from the 2007-2014 Triennial Review fiscal note, expressed as 30-year NPVs. Previously, 20-year NPVs were used.

Private Sector Impacts

The Division did not specifically evaluate the impact of the proposed rules on private facilities subject to wastewater discharge permits.

State Government Impact

The proposed rules are not anticipated to have a direct economic impact on state government facilities. The Division's NPDES Wastewater Permit program already expects some workload impacts and operating costs (monitoring, etc.) due to the 2014 rules changes; these 2018 changes

will have little or no incremental impact. Any impact that does result will be absorbed within the existing budget.

The Division anticipates that these changes will not affect environmental permitting of NC Department of Transportation (NCDOT), of which four of five are domestic in nature; as such, there should be no economic impact to NCDOT. The NC DOT also has provided fiscal comments to DWR that indicated the proposed rule amendments were not anticipated to directly apply any new requirement or fiscal costs to the department.

Federal Government Impact

The Division did not specifically evaluate the impact of the proposed rules on federal facilities subject to wastewater discharge permits. Five of the seven are domestic in nature. The two largest facilities serve military bases and are similar in many respects to large municipal facilities. It is possible that one or both could be impacted by the new rule changes, but that will not be determined until the standards are applied at the next permit renewals.

Distribution of Impacts Among Sectors

The Division conservatively estimated the impacts of the proposed rule changes based on impacts to municipal/ local government facilities only, for reasons described above. It did not specifically evaluate the impacts on private, state, or federal sector facilities. However, *for the sake of illustration only*, and the preceding descriptions of sector impacts notwithstanding, the following table shows how the 2018 impacts would be distributed among the sectors if they occurred in the same proportions as in the 2014 analysis:

Hypothetical Distribution of Impacts Among Sectors (30-Year NPVs)

Category	2014 Costs in 2017 Dollars ($MM)	2018 Costs in 2017 Dollars ($MM)
Municipal	$162.2	$151.3
Industrial	$20.6	$19.2
GW Remediation	$9.7	$9.0
WTPs	$2.5	$2.3
Total	$194.9	$181.8

3.3. Benefits Analysis

The revised aquatic life-based metals standards are designed to prevent further water quality degradation and improve the quality of waters with high metals concentrations by reducing metals inputs to surface waters. The proposed rules are expected to accomplish these goals by establishing a protective instream concentration that is more reflective of the current science on metals toxicity to aquatic life in ambient waters.

A reduction in the concentrations of copper, silver, and zinc in the state's aquatic environment is expected to provide a direct ecological benefit to aquatic ecosystems and may indirectly benefit human uses as well; for example, by reducing human exposures to metals or aiding in the recovery of fishery resources. Some of the proposed rule benefits are quantifiable, while other benefits are discussed qualitatively.

The following sections first describe the expected use and non-use benefits of the proposed rules and the importance of water quality to North Carolina's economy. The section concludes by estimating the value of maintaining and enhancing water quality for aquatic life. The analysis is based on a national study of society's willingness to pay for improvements in water quality, customized to reflect North Carolina.

3.3.1 Use and Non-Use Benefits of Water Quality Improvements

Regulations aimed at environmental protection provide a wide range of benefits to the public. The economic benefits associated with this regulation revision can be grouped into two main categories; use and non-use benefits.

Use benefits include the direct and indirect use of environmental goods and services by humans (such as fish consumption, recreational fishing, and drinking water) and the option to use environmental goods and services at a future date or in future generations. Non-use values are associated with the public's desire to know that an environmental resource exists and is protected even if they do not expect to use the resource for their direct economic benefit.

Of these types of benefits, direct use values are the easiest to quantify because an economic market may exist for environmental products directly consumed by humans, meaning a monetary benefit is easier to estimate. The other benefits (indirect, future and non-use) are more difficult, and in some cases impossible, to accurately value, such as reduced human health risk from exposure to pollutants and protection of resources for future generations. However, these benefits are often just as important to society as the monetized benefits.

The Division anticipates that the proposed revisions to the water quality standards will provide use benefits to society in the following categories, as well as provide non-use benefits:

1. Maintenance and enhancement of aquatic biodiversity (through protection of aquatic habitats and organisms).
2. Maintenance or enhancement of the state's recreational and commercial fishing industries as well other aquatic recreational activities;

3. Reduced risk to human health, manifesting as avoided illness and death, avoided health care expenditures, and avoided productivity losses;[2] and
4. Economic development benefits.

Additional details about the use and non-use benefits associated with reducing heavy metals in surface waters is available in the 2007-2014 Triennial Review Fiscal Note.

3.3.2 The Importance of Water Quality to North Carolina's Economy

As well known, water is a big part of NC economy, and it plays a big role in business investment, in people's quality of living, and in various industries (like recreational and commercial fishery industry). Thus, maintaining its quality is an important instrument for NC's sustainable economic growth. The North Carolina's Ocean Economy report affirms that the ocean economy contributed $2.1 billion to GDP (Gross Domestic Product) in 2013, and the creation of an estimated 43,385 jobs (results are based on data from the National Ocean Economics Program, database derived from the U.S. Department of Labor, Bureau of Labor Statistics' Quarterly Census of Employment and Wages).[3] The mountains and piedmont water recreational activities also have a big impact in NC's economy, and total revenues from recreation and tourism in NC is estimated to be around $28.0 billion in annual consumer spending and creates around 260,000 jobs (2015 values, NC Outdoor Industry Association and NC Department of Commerce). The estimated state and local tax revenue from these industries is around $1.3 billion. For the aquaculture sector, NC Department of Agriculture reports that its revenue in 2014 was equal to $58,020,638.

Focused directly on water use and its economic impacts, according to NMFS (National Marine Fisheries Service), in 2015 there were 4.97 million recreational fishing trips to the coast, resulting in $1.6 billion of spending and the creation of an estimated 16,150 jobs. In the 28 counties that make up North Carolina's broader coastal region, overnight visitors spent $3.6 billion and 91 percent reported leisure as the primary purpose of their trip (NCDC, 2014).

3.3.3 Estimating the Value of Water Quality Improvement in North Carolina

The following sections will present an estimate of North Carolina households' willingness to pay for water quality improvements. Although only some of the expected benefits can be priced in the traditional marketplace, estimating willingness to pay for water quality improvements captures the value households place on these ecosystem services and associated activities.

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[2] See Appendix 2 for a summary of the toxicological effects of Zinc, Copper, and Silver

[3] North Carolina's ocean economy is defined as the economic activities that take place in the ocean, receive inputs from the ocean, and provide outputs to the ocean (e.g., pollution), including, but not limited to the coastal counties, coastal waters under the state's jurisdiction, and adjacent federal waters where relevant for the state's economy.
NC Ocean Economy: National Ocean Economics Program (NOEP), 2016. Ocean economy data. Available at http://www.oceaneconomics.org/Market/ocean/oceanEcon.asp

DEQ does not have the financial and staff resources to directly measure peoples' preferences for improved water quality through willingness to pay surveys. Instead, the department reviewed several national and regional economic research studies that evaluated households' willingness to pay for water quality improvements.[4] Research conducted by Huber et al (2006) was best suited to evaluating North Carolina's proposed regulatory change. Their research summarized the results of more than 4,000 national survey responses to estimate how people monetarily value changes in water quality.

Survey respondents provided valuations through a series of hypothetical choices between regions with better water quality and higher annual cost of living versus regions with lower water quality and lower annual cost of living. Survey responses were used to develop a mathematical model which was used to determine the national willingness to pay for good water quality.

This analysis relies on Huber's model to illustrate the potential magnitude of the benefits of the proposed rule changes. The model was customized with North Carolina-specific information on income, demographics, and existing water quality to adjust household willingness to pay for changes in water quality for quantifiable differences between the original study case and this policy case. This approach assumes the beneficiaries of the proposed rules, in this case the residents of North Carolina, have different characteristics, but similar tastes, as people in the nation as a whole.

Willingness to pay represents the value of the benefits associated with an incremental improvement in water quality. After accounting for several variables that affect willingness to pay, including the baseline water quality in the state, household income, environmental organization membership, and recreational use, results indicate that North Carolina households are willing to pay $10.44 per year,[5] on average, for each one percent improvement in water quality that benefits aquatic life.[6]

To calculate the *total* benefits of the proposed rules, the analyst must multiply this unit price by the *effect size*, or the amount of the expected change in water quality due to the reduction in heavy metals. In this model, the change is measured as the percentage of North Carolina's lake acres and river miles that are rated as good for fishing and swimming (fish consumption and prolonged contact with the water will not make you sick) and supportive of a healthy, balanced

[4] Eisen-Hecht, Jonathan I. and Randal A. Kramer (2002); Huber, Joel, W. Kip Viscusi, and Jason Bell (2006); Joo, Ruth Jihyung, (2001); Whitehead, John, (2005)

[5] Calculated in 2017 dollars.

[6] The Huber *et al.* model considers the value of overall water quality improvements while these rule proposals focus on control of only certain individual pollutants. The rules primarily affect aquatic life, with secondary impact on humans through aquatic life consumption and recreation. Huber et al determined that 35% of the overall value of water quality improvements is associated with aquatic life benefits, with the remainder attributable to value for fishing and swimming uses. The willingness to pay value specified for North Carolina was adjusted accordingly to isolate the value of the quality improvements directly attributable to these specific rule changes.

community of aquatic life.[7] High metals concentration are known threats to North Carolina's water quality.

For the purposes of this rule change, the *total* potential benefits cannot be monetized and compared directly to the expected costs of the proposed rules because the effect size - the amount of the improvement in water quality - is unknown. Although the Division believes these changes will lead to improved water quality, it is not possible to determine the absolute improvement in water quality that will result from the rule changes with the available data. The change in water quality will depend upon site-specific criteria such as the volume and makeup of the effluent, the unique chemistry of the receiving water body, and the type of intervention adopted by each facility.

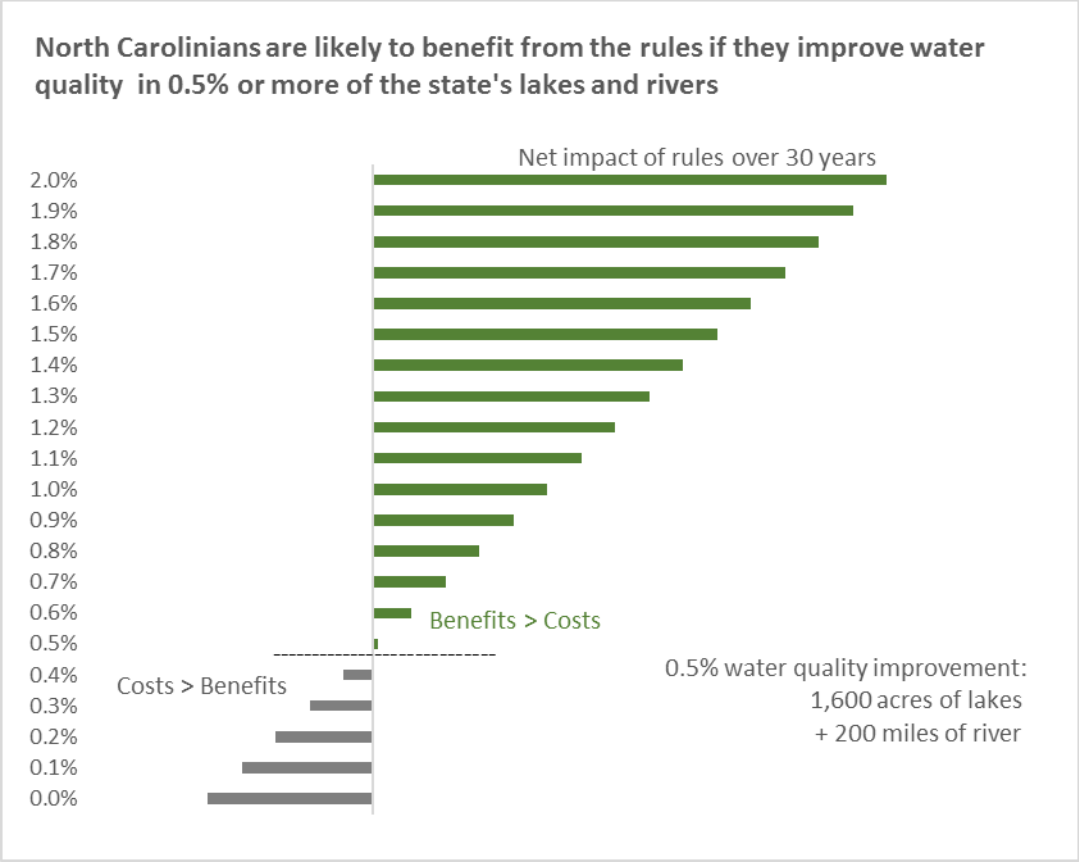
4. Total Economic Impact

Given that the extent of the water quality improvements from reduced copper, zinc and silver pollutants in North Carolina surface waters is unknown, the analysis below is intended to present the potential magnitude of the benefits and allow readers to judge whether the benefits are likely to exceed the estimated costs.

The proposed rules would affect 90 out of 1100 wastewater treatment plants in total. The estimated incremental impacts to the NPDES wastewater dischargers range from $103 million and $256 million with a mid-range estimate of $182 million for the first 30 years (calculated in 2017 dollars using a 7% discount rate).

Assuming that North Carolina households are willing to pay $10.44 per year, on average, for incremental aquatic life water quality improvements, the benefits of the proposed rules can be expected to exceed the costs if the rules improve water quality conditions in 0.5% or more of NC's water bodies. This change equates to approximately 1,600 acres of lakes and 200 miles of river (see chart below). The net impact of the rules is calculated over 30 years, assuming the benefits phase in gradually over the first 10 years of implementation as the regulated community renews their discharge permits.

[7] Huber *et al*, 2006.



Net impact calculated in 2017 dollars, using a 7% discount rate and a 2% annual inflation rate.

The likelihood of the benefits exceeding the costs (and by how much) is sensitive to several factors, including the range of the expected costs, the estimate of current baseline water quality, the percentage of households affected by the rules, and the discount rate. The effect of each of these variables is discussed in the following sections and the results are re-assessed under a range of reasonable assumptions.

Recommendations: The Division expects the social benefits of the proposed rules to exceed their costs, and believes the population of NC and its water ecology will be better off with the adoption of this regulation than without it. Recommending updating the copper, zinc and silver standards would keep the State ability to adopt Water Quality Regulations, while maintaining the EPA funds that are required to establish and implement NC ongoing water pollution control programs. It also keeps the State's ability to reduce economic burden on regulated parties.

5. Sensitivity Analysis

Performing a sensitivity analysis is important for testing the robustness of the results, identifying parameters to which the results are most sensitive, and communicating sources of uncertainty. The economic benefits were re-assessed using a range of assumptions for several key estimates and assumptions, including the range of the expected costs, the current baseline water quality, the percentage of households affected by the rules, and the discount rate.

Expected costs

The estimated incremental impacts to the NPDES wastewater dischargers range from $103 million and $256 million with a mid-range estimate of $182 million (see section 3.2). If the costs of the proposed rule are higher or lower than expected, the effect size (quality improvement) needed to justify the rule costs increases or decreases in turn. At the highest end of the cost range, a 0.7% or greater improvement in water quality would be required to justify the rule costs, compared to 0.5% if costs are $182M for the first 30 years.

Estimated Rule Cost ($MM)	Percent Change in Water Quality that Justifies Rule Cost
$103	0.3%
$182	0.5%
$256	0.7%

Baseline water quality

As of 2016, targeted monitoring assessments estimated that 78% of rivers miles and 61% of lake acres were rated as good for fishing, swimming, and aquatic life. These biennial assessments, available from the US Environmental Protection Agency's ATTAINS database (2016 survey results).[8] The assessments provide snap shots in time of the conditions of the state's waters based on the current water quality regulations in place at that point in time.

There is some uncertainty around these estimates because not every water body is assessed each year (36% of rivers and 75% of lake acres were assessed in 2016), and the methodology for calculating impairment is also changing. However, individuals place a greater value on improving the highly degraded waters compared to continuing to improve cleaner waters.

The table below presents the results of the analysis under a range of baseline water quality estimates. The sensitivity analysis shows that the incremental willingness to pay estimates and the associated effect size (quality improvement) needed to justify the cost does not vary substantially with changes in the baseline water quality.

Baseline water quality (% meeting all assessed uses)		Annual HH Willingness to Pay for Incremental Improvement	Percent Change in Water Quality that Justifies Rule Cost
Lakes	Rivers		
51%	68%	$11.18	0.47%
56%	73%	$10.79	0.49%
61%	78%	$10.44	0.50%
66%	83%	$10.13	0.52%
71%	88%	$9.85	0.53%

[8] Accessed at https://ofmpub.epa.gov/waters10/attains_state.control?p_state=NC&p_cycle=2016

Percentage of households affected

NPDES point source facilities are scattered throughout the entire state so the Division assumed that 100 percent of the population may receive benefits from the rule proposals. At a minimum, these rule proposals will maintain the existing water quality in all waters and prevent future degradation due to metals. The table below tests the sensitivity of the result under different assumptions about the affected population. As the proportion of households affected declines, the the change in water quality that is needed to justify the rule costs increases.

Percent of Population Affected	Percent Change in Water Quality that Justifies Rule Cost
20%	2.51%
40%	1.26%
60%	0.84%
80%	0.63%
100%	0.50%

Discount rate

The choice of the discount rate[9] also has a considerable influence on the net impact of the rules. In the model scenario, a discount rate of 7% is applied, as required by G.S. 150B. The sensitivity analysis below presents the effect of using discount rates ranging between 3.5% and 10%. In general, higher discount rates diminish the present value of benefits occurring in the future. Therefore, the likelihood of the benefits exceeding the costs is greater if one assumes a lower discount rate, while the reverse is true if one assumes a higher discount rate.

Discount Rate	Percent Change in Water Quality that Justifies Rule Cost
3.5%	0.27%
5.0%	0.36%
7.0%	0.50%
8.5%	0.64%
9.5%	0.74%
10.0%	0.80%

[9] [Define discount rate]

6. References

1. Ajmal, M., Rao, R.A.K., Anwar, S., Ahmad, J., and Ahmad, R., 2003.
2. Ahalya N., Ramachandrl T.V. and Kanamadi RD., Biosorption of Heavy Metal Research Journal of Chemistry and Environment, Vol.7pp4, Dec. 2003.
3. City of Raleigh 2014-2015 Comprehensive Annual Financial Report, 2015.
4. Congressional Budget Office, "Public Spending on Transportation and Water Infrastructure" (2010), available at http://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/119xx/doc11940/11-17-infrastructure.pdf.
5. Corso, Phaedra S., Kramer, Michael H., Blair, Kathleen A., Addiss, David G., Davis, Jeffrey P., & Haddix, Anne C. 2003. Cost of Illness in the 1993 Waterborne Cryptosporidium Outbreak, Milwaukee, Wisconsin. http://www.cdc.gov/Ncidod/eid/vol9no4/02-0417.htm.
6. Dumas, Christopher, Peter W. Schuhmann, John C. Whitehead, Measuring the Economic Benefits of Water Quality Improvement with Benefit Transfer: An Introduction for Noneconomists, the American Fisheries Society, 2005.
7. Eisen-Hecht, Jonathan I. and Randal A. Kramer Estimating the economic value of water quality protection in the Catawba River basin. Water Resources Research 38:1182–1191; 2002.
8. Eisler, Ronald, Zinc Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review, Biological Report 10, 1993.
9. Environmental Protection Agency, 2006 Community Water System Survey.
10. Feenberg, D., and E. S. Mills. 1980. Measuring the benefits of water pollution abatement. Academic Press, New York.
11. Guy Hutton and Laurence Haller, Evaluation of the Costs and Benefits of Water and Sanitation Improvements at the Global Level, WHO, Geneva 2004
12. Houtven, George Van, John Powers, and Subhrendu K. Pattanayak, Valuing water quality improvements in the United States using meta-analysis: Is the glass half-full or half-empty for national policy analysis? Resource and Energy Economics 29 (2007) 206–228
13. Huber, Joel, W. Kip Viscusi, and Jason Bell. 2006. "Economics of Environmental Improvement" EPA Cooperative Agreement CR823604 and Grant R827423 to Harvard University with the National Center for Environmental Economics.
14. Johnston R.J., K. Segerson, E.T. Schultz, E.Y. Besedin, and M. Ramachandran. 2011. "Indices of Biotic Integrity in Stated Preference Valuation of Aquatic Ecosystem Services." Ecological Economics 70(11):1946–56.
15. Johnston, Robert J., Elena Y. Besedin & Ryan Stapler, Enhanced Geospatial Validity for Meta-analysis and Environmental Benefit Transfer: An Application to Water Quality Improvements, Environmental Resource Economics (2017) 68:343–375.
16. Johnston, Robert J., Elena Y. Besedin, Estimating Willingness to Pay for Aquatic Resource Improvements Using Benefits Transfer, Chapter 7 book Environmental Economics for Watershed Restauration, CRC Press 2009.
17. Joo, Ruth Jihyung, Public Willingness to Pay for Ecosystem Services: Water Quality in the Triangle region, Master thesis, Nicholas School, Duke University, NC, Sept 2011.
18. Logar, Ivana, Roy Brouwer, Max Maurer, and Christoph Ort, Cost-Benefit Analysis of the Swiss National Policy on Reducing Micropollutants in Treated Wastewater. Environmental Science Technology Policy Analysis, Journal, September 24, 2014.

19. Miller, Keith, Kristina Costa, and Donna Cooper, "Creating a National Infrastructure Bank and Infrastructure Planning Council: How Better Planning and Financing Options Can Fix Our Infrastructure and Improve Economic Competitiveness," Center for American Progress, September 2012.
20. National Academy of Science, Zinc. National search Council, Subcommittee on Zinc. University Park Press, Baltimore, d. 71 pp, 1979.
21. National Ocean Economics Program (NOEP). 2016. Ocean economy data. Available at http://www.oceaneconomics.org/Market/ocean/oceanEcon.asp
22. North Carolina Division of Marine Fisheries, 2017 Annual Report, November 2017, http://portal.ncdenr.org/c/document_library/get_file?p_l_id=1169848&folderId=31127300&name=DLFE-135240.pdf
23. North Carolina's Ocean Economy, January 2017, North Carolina Sea Grant, et al.
24. North Carolina Department of Commerce, 2015, https://www.nccommerce.com/LinkClick.aspx?fileticket=2vuxET_5uHA%3D&tabid=1586&mid=4665
25. North Carolina Department of Environmental Quality, 2014 Local Water Supply Plan https://www.ncwater.org/Water_Supply_Planning/Local_Water_Supply_Plan/report.php?pwsid=03-92-010
26. North Carolina Outdoor Industry, 2017, https://outdoorindustry.org/resource/north-carolina-outdoor-recreation-economy-report/
27. Nordberg, GF, BA Fowler, M Nordberg, and LT Friberg. 2007.Handbook in the toxicology of metals. Elsevier. NY.
28. Randall, Alan, John R Stoll, Consumer's surplus in commodity space, The American Economic Review Vol. 70, issue 3, pages 449-455, 1980.
29. Shafiquzzaman Siddiquee, Kobun Rovina, Sujjat Al Azad, Laila Naher, Saallah Suryani and Pasicha Chaikaew, Heavy Metal Contaminants Removal from Wastewater Using the Potential Filamentous Fungi Biomass: A Review, Journal of Microbial & Biochemical Technology, 2015.
30. Solbe, J. F. D. L. G., and V. A. Flook. Studies on the toxicity of zinc sulphate and of cadmium sulphate to stone loach Noemacheilus barbatulus (L) in hard water. Journal of Fish Biology 7:631-637, 1975.
31. Tierney, KB, DH Baldwin, TJ Hara, PS Ross, NL Scholz, and CJ Kennedy. 2010. Olfactory toxicity in fishes. Aquatic Toxicology 96(1): 2-26
32. U.S. EPA. "The Metals Translator: Guidance for Calculating a Total Recoverable Permit Limit from a Dissolved Criterion." EPA 823-B-96-00, June 1996. http://water.epa.gov/scitech/datait/models/upload/2009_03_26_models_guidance_pdf.pdf
33. Whitehead, John, Improving Willingness to Pay Estimates for Quality Improvements Through Joint Estimation with Quality Perceptions, US EPA National Center for Environmental Economics, working paper #05-08, August 2005
34. Weitzman, Martin L. On the 'Environmental' Discount Rate. Journal of Environmental Economics and Management. 1994; 26 :200-209.

7. Appendices

1. Policy Alternatives

The following alternatives were considered during the development of the 2014 Triennial Review Fiscal Note package.

Alternative 1 – Recommending no changes to current surface water quality standards

One alternative considered was not to make any changes; however, there were several factors that made this alternative unattractive. A major consideration is that taking no action to update the state's standards for metals may result in the US EPA promulgating revised standards per the Clean Water Act Section 303(c)(4)(B) to bring North Carolina's regulations into accordance with 304 (a) National Recommended Water Quality Criteria (NRWQC).

The US EPA and a variety of stakeholders have requested that DWR review and update the state's water quality standards protective of aquatic life. This update is needed in order to address differences between North Carolina's standards regulations and the NRWQC and other applicable federal regulations.

Costs to regulated parties associated with choosing a "no action" alternative would hinge on whether US EPA promulgated revised standards for the state to meet CWA requirements. Exact costs to the state that could result from federal water quality standards promulgation cannot be quantified but could likely be significant. Should the State fail to modify standards in a scientifically defensible and timely manner, the US EPA could make an Agency determination that NC was out of compliance with the Clean Water Act obligations. It is possible that the DWR will lose millions in funds required to establish and implement its ongoing water pollution control programs.

The US EPA has published additional NRWQC not considered or incorporated into this proposal, so, other impacts may occur if the federal promulgation takes place. Under a federal promulgation scenario, the state could lose the ability to adopt balanced regulations that attempt to reduce the economic burden on regulated parties while maintaining protection for the environment.

Also, under G.S. §150B-21.3A, the Department is required to evaluate each of its existing rules and make an initial determination as to whether the rules are:

Necessary with substantive public interest – the agency has received public comment on the rule within the past two years or the rule affects the property interest of the regulated public, and the agency knows or suspects that any person may object to the rule.

Necessary without substantive public interest – the agency determines that the rule is needed, and the rule has not had public comment in the last two years. This category includes rules that identify information that is readily available to the public, such as an address or telephone number.

Unnecessary – the agency determines that the rule is obsolete, redundant or otherwise not needed.

The Department must then determine which rules are still necessary and propose to re-adopt, with or without modifications, or to repeal each rule as appropriate.

After considering these factors, the Division decided to move forward with developing modifications to the water quality standards regulations.

Alternative 2 – Recommend Site-Specific Standard Derivation for Copper, Zinc, and Silver Standards

In accordance with the US EPA Water Quality Standards Handbook, the state may adopt site-specific water quality standards/criteria where the National Recommended Water Quality Criterion (NRWQC) is believed to be unrepresentative of the State's aquatic ecosystem conditions, the national criteria may be modified to account for specific conditions found at a "site" using US EPA guidelines. The US EPA defines a "site" as being the entire state or region, watershed, waterbody, or a certain segment of a waterbody (EPA WQS Handbook, 1994, with subsequent amendments).

Per North Carolina regulations, 15A NCAC 02B .0226, "Exemptions from Surface Water Quality Standards", site-specific water quality standards may be granted by the Environmental Management Commission (EMC). Pursuant to federal regulations at 40 CFR 131.10 (g), site specific standards are subject to public review under the federal Clean Water Act Triennial Review. Adoption of a site-specific standard, therefore, is subject to the NC Administrative Procedures Act and to review and approval by the US EPA. The option to establish site-specific criterion for each of these metals was examined to determine if it was a feasible alternative to statewide standards employing the formula based approach.

The US EPA describes three allowable methods for deriving a site-specific water quality standard for the protection of aquatic life (EPA WQS Handbook, 1994).

1. Recalculation Procedure
2. Water Effects Ratio Procedure
3. Resident Species Procedure

A 4th method for Copper is to allow the use of a Biotic Ligand Model (BLM) to derive Copper site-specific criterion. This BLM uses information on 10 co-parameters to derive very individualized criterion. As the state does not currently have information with respect to all 10 co-parameters in all water bodies, this mechanism was deemed extremely cost and labor intensive and was ruled out almost immediately

As the state provided for the use of the Water Effects Ratio and the use of the BLM in the previous adoptions, as requested by an individual, the use of the other two options were

examined more closely for processes that would need to occur before widespread SSC derivation occurred across the state. The first step in any decision to alter a standard is to determine that the alteration is necessary:

1) The state examined the need to examine sampling data at each location to determine if the use of "clean technique" in a laboratory sampling and/or analysis may reduce the level of the metal reported to be in the sample such that the problem of needing a revised standard is resolved. To accomplish this first task, for every defined "site" in the state, was daunting. Each site would need to:

- Identify potential sources of contamination (sampling location access, laboratory use of fans, high dust areas)
- Examine basic sample handling processes (field sampling, laboratory handling and analysis)
- Examine sampling equipment cleaning procedures (jugs/bottles/samplers/strainers/reagent quality)
- Examine laboratory equipment for potential sources of contamination (digestions, containers, talc free gloves)
- Examine solvents/rinsates for potential contamination (reagent quality, special metallic removing soaps)
- Collect field reagent blanks for monitoring purposes
- Purchase "clean room gloves"; eliminate "paper towels" – replace with clean room wipes
- Assure that sampling personnel are non-smokers

2) "Site" boundaries for any potential revised standard must be defined in detail. As each request would be "site-specific", no valuable estimates could be easily made to determine the extent and number of SSC that would be needed. (A basin, a watershed, a waterbody)

Costs associated with the Recalculation Procedure (EPA-823-B-94-001, Appendix B):

The Recalculation procedure is used to derive a site-specific standard/criterion (SSC) when the resident aquatic species specific to a site are believed to exhibit a different range of toxicity values than those used in the national or state criteria calculation. The US EPA allows for additions and/or deletions (or corrections if needed) of the aquatic toxicity data used in deriving the national criterion. This is permissible when it can be documented that doing so better reflects the aquatic organism assemblages specific to a site. The Recalculation Procedure specifies that to delete a species from a metal's national data set, documentation must be made that the aquatic species does not exist at the defined and delineated site continually or intermittently. This procedure is most often performed by an environmental consultant with expertise in the field of aquatic toxicity/biology as this is a critical step in obtaining the state adoption and the US EPA approval for the use of the revised site-specific standard.

Again, to perform this examination for each defined site would be time-consuming and staff resource intensive.

- The US EPA defines organisms that "occur at a site" as the species, genera, families, orders, classes, and phyla that are usually present at the site or present seasonally or intermittently. Organisms are also considered to occur at a site if they were present at the site in the past but are not currently at the site due to degraded conditions or if they are found to be present in nearby bodies of water. Under certain circumstances, the species proposed for deletion also must not be representative of another species in the same family that does exist at the site.

- Recalculation of a state or national criterion may result in a more or less stringent site-specific standard depending on the sensitivity of the species present at the site. For example, NC's proposed freshwater aquatic life standards for cadmium were based on a recalculation of the NRWQC conducted by Chadwick Ecological Consultants (for the Association of Metropolitan Sewerage Agencies). This recalculation added newer toxicity data and deleted data, where allowable, resulting in standards which are slightly less stringent than the national criteria. Understanding how specific this assessment would be, the costs incurred to perform would , again, be challenging.

- Site specific standards developed using the recalculation procedure must be adopted into state regulations and be approved by the US EPA.

3) The Resident Species Procedure

The Resident Species Procedure can be used when both site water chemistry and resident species sensitivity to a toxic are in question. This procedure requires aquatic toxicity tests to be conducted with the site's resident species in actual site ambient water. After the toxicity test data are gathered by performing the necessary tests with a sufficient selection of resident species in site water, calculation of a site-specific standard can be done. The site-specific standard is derived by following the aquatic life criteria derivation procedures as described in the US EPA 1985 guidelines (Stephan et al 1985).

- As with the other options for developing site specific aquatic life standards, state rulemaking and US EPA approval are required
- The resulting site-specific standard can be more or less stringent based on-site characteristics, meaning that costs are calculated on a site-specific basis and can be extremely variable

In summary, site-specific criteria across the state would be much more challenging to accomplish that allowing the use of SSC derivation on a case-by-case basis. The staff of the CSS/RRB did not have sufficient information to derive a cost estimate and benefit estimate in accordance with protocol. It was determined that costs, staff time, and resources to accomplish this alternative would be sufficiently higher that establishment of one standard for each of the metals to be used with site-specific hardness as currently proposed.

2. Summary of the Toxicological Effects of Zinc, Copper, and Silver

Heavy metals are not biodegradable and tend to accumulate in living organisms and many heavy metal ions are known to be toxic or carcinogenic. Heavy metals cannot be destroyed through

biological degradation, as is the case with most organic pollutants. Incidence of heavy metal accumulation in fish, oysters, mussels, sediments and other components of aquatic ecosystems have been reported from all over the World (Shafiquzzaman et all, 2015). Excessive amounts of some heavy metals can be toxic through direct action of the metal or through their inorganic salts or via organic compounds from which the metal can become easily detached or introduced into the cell. The problem of heavy metal pollution in water and aquatic organisms including fish, needs continuous monitoring and surveillance as these elements do not degrade and tend to biomagnified in man through food chain. In view of the above toxicological effects of heavy metals on environment, animals and human beings, it becomes imperative to treat these toxic compounds in wastewater effluents before they are discharged into freshwater bodies.

Below is a summary of toxic effects from zinc, copper and silver, that are concerning for the treatment of industrial wastewaters.

1. **Zinc (Zn)**

- **Human being**: Zinc is a trace element that is essential for human health. However, too much zinc can cause eminent health problems, such as stomach cramps, skin irritations, vomiting, nausea and anemia (Ahalya N at all, Dec. 2003). The pancreas and bone seem to be primary targets of zinc intoxication in birds and mammals (Ronald Eisler, 1993).
- **Fish community**: Gill epithelium is the primary target site in fish. Aquatic populations are frequently decimated in zinc-polluted waters (Solbe, 1975). At acutely toxic concentrations it kills fish by destroying gill tissues. At chronically toxic levels it may induce stress resulting in death.

2. **Copper (Cu)**

- **Human being**: Copper does essential work in animal metabolism. But the excessive ingestion of copper brings about serious toxicological concerns, such as vomiting, cramps, convulsions, or even death (overdoses of Cu are documented and symptoms in humans at 44 mg Cu/L or less include gastrointestinal distress, nausea, vomiting, headache, dizziness, and metallic taste in mouth; higher doses can cause coma and death (Ajmal, 2003). Copper is highly toxic because it is non-biodegradable and carcinogenic. Copper has been reported to cause neurotoxicity commonly known as " Wilson's disease " due to deposition of copper in the lenticular nucleus of the brain and kidney failure. Humans afflicted with Wilson's disease, children under one year, people with liver damage, chronic disease, and diabetes are more susceptible to Cu poisoning (Nordberg et al. 2007).
- **Fish community**: Copper is acutely toxic (lethal) to freshwater fish in soft water via the gills at low concentrations ranging from 10 –20 part per billion (National Academy of Science 1979). Cu can impair behaviors important to survival and reproduction by reducing a fish's sense of smell and/or orientation ability. According to Tierney et al. 2010, copper is known to reduce fish resistance to diseases; it disrupts migration; alters swimming; causes oxidative damage; impairs respiration; disrupts osmoregulation structure and pathology of kidneys, liver, gills, and other stem cells; impacts mechanoreceptors of lateral line canals; impairs functions of olfactory organs and brain;

is associated with changes in behavior, blood chemistry, enzyme activities, corticosteroid metabolism and gene transcription and expression.

3. Silver (Ag)

- **Human being**: The only known clinical picture of chronic silver intoxication is that of argyria. Animal studies suggests that long-term exposure (125 days) to moderately high levels of silver nitrate in drinking water may have a slight effect on the brain because exposed animals were less active than animals drinking water without silver. Another study found that some of the animals that drank water containing moderately high levels of silver for most of their lives (9 months or longer) had hearts that were larger than normal. It is not yet known whether these effects would occur in humans. Silver is regulated by US Environmental Protection Agency (EPA) National Secondary Drinking Water Regulations. The secondary maximum contaminant level in public water supplies (finished drinking water) is 0.1 mg/liter, which is a non-enforceable guideline based on possible cosmetic effects, such as skin discoloration. Silver oxide is harmful upon swallowing, because it irritates the eyes, respiratory tract and skin. Silver nitrate is much more harmful, because it is a strong oxidant. It causes corrosion and at oral uptake it leads to vomiting, dizziness and diarrhea.
- **Fish community**: Studies on fish and zooplankton exposed to high doses of silver nitrate confirmed that silver in this form is highly toxic to aquatic creatures. This ionic form of silver interferes with an enzyme that regulates the level of potassium and sodium in fish. Disturbing the sodium/potassium equilibrium has fatal effects on the fish community, and similar effects were found in zooplankton.