STATE OF NORTH CAROLINA
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

REPORT OF PROCEEDINGS ON THE PROPOSED CHANGES TO THE SURFACE WATER QUALITY STANDARDS AND CLASSIFICATIONS RULES FOR THE TRIENNIAL REVIEW

Public Hearings

July 24, 2006
Mooresville, NC

July 25, 2006
Raleigh, NC

July 26, 2006
Wilmington NC

TABLE OF CONTENTS

BACKGROUND

Every three years the State is required by the Clean Water Act (CWA) to review its surface water quality standards and classifications to determine if any changes are needed, and, if necessary, to enact those changes. This review process is known as the "Triennial Review." In addition, as part of the Triennial Review, the CWA mandates a review of any variances to surface water quality standards that have been issued by the State. The current iteration of the Triennial Review that is the subject of this document covers the period 2004-2006.

The 2004-2006 Triennial Review was initiated in the summer of 2005. During the 2005 –2006 timeframe, a series of 18 presentations was conducted to present the proposed standards to affected parties and to solicit comments and concerns from the public about these proposals. These meetings also allowed time for the US EPA, the public and the staff of the Division of Water Quality to openly discuss these changes (Attachment A-1). The US EPA provided input to the process, requesting revisions to a number of parameters. In accordance with State regulations, permission to proceed to Public Hearing with the proposals was received from the Water Quality Committee in January 2006 and from the Environmental Management Commission in March 2006. A Notice of Text for the 2004-2006 Triennial Review was published in the July 1, 2006 edition of the *North Carolina Register* (Attachment A-2). Three public hearings were held in July. These public hearings were held in three towns geographically chosen to maximize public input (Attachment A-3).

The hearing announcement was mailed either electronically or in hard copy form to all individuals on the Water Quality mailing list and those on the Rulemaking Notice list (Attachment A-4). In addition, notice was sent via the Division of Water Quality's Public Information Officer to several major newspapers throughout North Carolina and to all list serve members (Attachment A-5). A public information package was developed for the public hearings. This package contained all the proposed standard changes and rule amendments, variances, and any other material that was the subject of public comment at the hearings. This package was made available to the public in an electronic form via the Internet. Written comments on this material were accepted, in accordance with the North Carolina Administrative procedures Act, until the close of the public comment period on September 1, 2006.

SUMMARY OF PROPOSALS

The proposed water quality standard changes that were presented at the public hearings for the 2004- 2006 Triennial Review are briefly summarized below:

1. The US EPA has published revisions of Ambient Aquatic Life Water Quality Criteria for Cadmium (EPA 822-R-01-001; April 2001) and Tributyltin (EPA 822-R-03-031; December 2003). The proposed revisions to the Cadmium and Tributyltin standards are designed and recommended to protect sensitive aquatic life.

2. EPA Revised Guidance: Many of the current North Carolina Water Quality Standards (WQS) are derived using the Environmental Protection Agency (EPA) 1980 Ambient Water Quality Criteria (AWQC) National Guidelines for developing human health

protective concentrations (*Federal Register*, November 28, 1980 (45 FR 79318)). The November 1980 *Federal Register* notice also summarized the criteria documents and discussed in detail the methods used to derive the AWQC for those pollutants.

Designed to protect human health, these criteria are developed under Section 304(a) of the CWA of 1972 by assessing the relationship between pollutants and their effect on human health and the environment. The Clean Water Act requires EPA to develop, publish and revise ambient water quality criteria. Based upon this CWA requirement, the US EPA published "Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000), EPA-822-B-00-004, October 2000), hereinafter referred to as the "2000 Human Health Methodology". The EPA then issued revised criteria in two documents: "National Recommended Water Quality Criteria: November 2002" (EPA-822-R-02-047) and a subsequent Federal Register Notice (68 FR 75507, December 31, 2003). The EPA's 2000 Human Health Methodology updated human health criteria equations allowing scientific advancements to be utilized in the 2002 federally recommended criteria. The federal water quality criterion revisions were based on a partial update of pollutants' toxicological risk assessments: new or revised reference doses (RfD), updated carcinogenic potency factors (CPF), updated national default freshwater/estuarine fish consumption rate (17.5 g/day) and, in some cases, relative source contribution values (RSC). As applied by the 15A NCAC 2B rules, staff has recommended modifications to narrative or numerical concentrations for 18 chemical pollutants. These proposed human health standards would affect waters classified as Class C (all freshwaters) and Class WS (water supply waters) and Salt waters (Class SC).

3. The Water Quality Bacteria indicator standard for saline waters (Class SA, SB and SC) will change in direct response to the federal Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000. The EPA has determined that, in saline waters, the use of enterococci as a bacterial indicator is a better predictor of potential gastrointestinal distress. Upon US EPA approval and removal of the current Federal promulgation, our current standard of fecal coliform will be removed in all saline waters except Class SA (shellfish waters). Shellfish waters are under the jurisdiction of both the EPA and the Food and Drug Administration (FDA). The FDA believes that the fecal coliform indicator is better suited for the protection of human health from the consumption of contaminated shellfish. Waters classified as SA therefore will maintain dual indicators.

4. Beryllium was reviewed as part of the updated changes to human health criteria. It was determined that the US EPA no longer considers Beryllium a human carcinogen by the oral route and has removed the previously published Oral Slope Factor from the Integrated Risk Information System data base (Attachment A-6)). After consultation with the US EPA, and in consideration of the existing 15A NCAC regulations, Beryllium is proposed for removal from the current human health protective regulations. Beryllium will remain at 6.5 ug/L for aquatic life protection.

5. Public comment was solicited on the existing water quality and thermal variances and possible future changes to North Carolina's Water Quality Standards program.

SUMMARY OF THE ORAL and WRITTEN COMMENTS

Public hearings for the Triennial Review were conducted in Mooresville, Raleigh and Wilmington on July 24th, July 25th and July 26th respectively. Ms. Dianne Reid, Supervisor with the Intensive Surveys Unit, Environmental Sciences Branch, NC DENR/Division of Water Quality, served as Hearing Officer (Attachment A-7). Eight individuals attended the Mooresville hearing and one chose to make a public comment. At the Raleigh hearing, 43 individuals attended, with one requesting to comment. Eleven individuals attended the Wilmington hearing, two people elected to make comments. A list of those attending the hearings is contained in Attachment A-8. The Hearing Officer's remarks are presented in Attachment A-9.

A taped transcript of the oral comments received at the hearings will be provided upon request. A total of 41 written comments were received prior to the close of the comment period on September 1, 2006. These written comments are contained in Attachment A-10. The following is a summary of all oral comments that were presented at these hearings and a summary of all written comments received, along with a brief response. .

1. Cadmium Standard Comments

Proposed Revised Aquatic Life Standard:	**0.16 ug/L**
Current Aquatic Life Standard:	2 ug/L

Opposition Comments From:

Representatives of the Cities of Greensboro, Charlotte and Wilmington provided oral comments on behalf of their respective cities and the NC Pre-treatment Consortium

NC Pretreatment Consortium, Inc.

22 template letters representing 15 North Carolina cities and one NC County

North Carolina Water Works Association (AWWA)

Water Environment Associations

Neuse River Compliance Association

The Lower Neuse River Basin Association

Duke Energy Corporation

Opposition Comments *received indicated similar identified points of concern and are bulleted (•) and outlined below:*

- ***Comment:*** *The proposal has no review or consideration of appropriateness for the State of NC. Adoption of the EPA criterion is not consistent with previous NC efforts to have separate criteria for designated Trout and Non-trout waters.*

Response: Trout have historically been the most sensitive species for numerous toxicants; however, the most sensitive species in the revised National dataset is *Hyalella azteca*, commonly known as scuds. Removal of the trout data does not result in a higher standard for non-trout waters as has been the case in the past. The scud is found throughout NC in streams, lakes and ponds. In direct accordance with the established EPA protocol for development of aquatic life protective standards, this data *cannot* be removed.

- ***Comment:*** *Several states have taken issue with EPA and one has had alternative criteria approved and another is pursuing the resident species approach for statewide criteria.*

  "The National Association of Clean Water Agencies (NACWA) funded a study by GEI Consultants- Chadwick Ecological Division (GEI-CED) to review the EPA criterion. After appropriate consultation with the US EPA, GEI-CED proposed alternative coldwater and warm water acute and chronic criteria, specifically for agencies within the State of Colorado. The US EPA accepted water quality standards modifications for the state of Colorado that included separate acute criteria equations (based on hardness) for warm water and coldwater streams, and a modified chronic criteria equation.

  These (aforementioned) reviews would be useful starting points to improve upon the previous standard development work in NC where separate standards were developed for trout and other surface waters."

Response: Under the Federal Water Pollution Control Act (the Clean Water Act), States are required to review their existing standards and determine if they contain a level of protection to maintain both aquatic life and human health. At the request of the US EPA, with the US EPA 2001 publication of "Ambient Aquatic Life Water Quality Criteria for Cadmium (EPA 822-R-01-001) staff began review of the document to determine applicability for the State. Consultations with staff aquatic toxicologists at the Environmental Science Section did not reveal any major issues or concerns with the document.

Furthermore, the United States Fish and Wildlife Service (USFWS) has provided comments (Attachment A-10, page 170) which indicate that the USFWS review of the proposed revision was "consistent with the US EPA".

Upon receipt of the GEI-CED review of the US EPA criterion, which included additional studies published after the 2001 publication by the EPA, staff began extensive research to validate the proposal by the Pre-treatment Consortium.

The following is summary of actions based upon the GEI-CED proposed recalculation (Attachment A-11). These were implemented in the State of Colorado with the effective date of rule implementation, January 1, 2007.

1. GEI-CED removed one acute data set, for the African Claw frog, a species identified as having been introduced to the US, but currently not having any widespread habitat in the US. Their current North American habitat is limited to specific southwest locales. Additionally some data points were removed from the national data set – which creates a slight modification to the Final Chronic Value. These changes have been deemed correct and in accordance with US EPA and NC protocol for development of water quality standards.
2. As a result of the GEI-CED recalculation, the State of Colorado will apply a 0.252 ug/L *dissolved* Cadmium standard in waters classified as E, P, N, U-1 and U-2. These classifications correspond to NC's Classifications of B and C waters (Per Colorado Regulation 31- Basic Standards and Methodologies for Surface Water , Amended 8/8/05, effective 12/31/05 and 12/31/07).

Using data and recalculations supplied by both the Pre-treatment Consortium and additional information supplied directly by GEI, the equivalent *total* cadmium standard applicable to NC waters at 50 mg/L hardness is *0.27 ug/L.* (Attachment A-10)

- ***Comment:*** *Although water quality standards in North Carolina have generally been based on a hardness of 50 mg/L, adoption of a single standard based on this hardness may be overly protective for effluent dominated streams where hardness may be considerably higher than 50 mg/L under low flow conditions used for development of permit limitations. In addition, the standard based on a hardness of 50 mg/L may not fully protect streams with very low hardness –particularly trout streams. Consider alternative approach for addressing hardness that provides more flexibility in the application of criteria to NPDES permits.*

Response: The standard is written to allow for the development of site specific standards: "attainment of these water quality standards in surface waters shall be based on measurement of total recoverable metals concentrations unless appropriate studies have been conducted to translate total recoverable metals to a toxic form" (15A NCAC 2B .0211(3)(1)(iii)). These translators allow the use of site-specific hardness, in addition to other site-specific parameters.

- ***Comment:*** *No waters have been specifically identified as impaired for cadmium in the most recent 303(d)/305(b) report and few if any surface waters were listed as impaired for metals. While routine analytical testing only detects cadmium to a level of 1 to 2 ug/l, the absence of any impaired waters for cadmium and identification of cadmium in fish tissue at levels of concern supports an approach that allows careful review and development of specific criteria applicable to the waters of the State of North Carolina.*

Response: Under the Federal Water Pollution Control Act, (the Clean Water Act), standards are established by the State to provide for the "protection and propagation of fish, shellfish, and wildlife." Development of the standards is mandated to protect the waters from becoming impaired.

- ***Comment:*** *Work with DWQ's Environmental Sciences Section to identify aquatic species that should be included in the recalculation of EPA's criterion for use in North Carolina.*

Response: The staff of the Environmental Sciences Section (ESS) was consulted on numerous occasions during the Triennial Review process. Their expertise was invaluable to determine if the proposal and course of action to lower the standard would, or could, prove to be beneficial to the conditions of waters in the state. The ESS staff reviewed the US EPA document and provided comprehensive review of the national data set for potential modifications, including a derivation to use only native North Carolina species. Because the most sensitive species identified in the US EPA proposal are NC native species, no further removal was warranted. Removal of a few specific data points, as identified above, offered some change to the standard and has been approved by the ESS staff.

- ***Comment:*** *There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium at 0.16 ug/L. No laboratory can achieve the level of detection needed to lower reporting level.*

Response: Staff investigated reporting levels (PQLs) and methods (Attachment A-12) used by the following facilities:

- 12 laboratories currently certified by the NC Division of Water Quality Chemistry Laboratory 's Laboratory Certification Unit,
- the NC Division of Water Quality Chemistry Laboratory,
- four US Fish and Wildlife Service contract laboratories, and
- the US EPA Region IV Athens Georgia laboratory.

The "Practical Quantitation Limit (PQL) is about 5 times the MDL and represents a practical and routinely achievable detection level with a relatively good certainty that any reported value is reliable" (Standard Methods for the Examination of Water and Wastewater, 20th Edition). It was determined that 13 of the 18 laboratories could report to 1 ug/L using 40 CFR Part 136 approved "US EPA method 200.8" and sample digestion by "US EPA method 200.2". This constitutes the commonly used and available Inductively Coupled Plasma –Mass Spectroscopy method. Two laboratories located in South Carolina are currently certified by the State of NC to analyze and report Cadmium to 0.1 ug/L. The State of South Carolina adopted and implemented the National Ambient Water Quality Criteria for Total Cadmium at 0.16 ug/L and have required their certified labs to report at this level for several years.

- ***Comment:*** *NPDES permits: If placed into the NPDES permit – permittees will not be able to demonstrate compliance with the limit. Quantitation level language will have to be placed in the permit that concentrations below the lower reporting limit will be considered compliant.*

Response: NPDES permits require facilities to report only to the lowest detection and reporting level. Compliance is therefore determined at the PQL or "reporting level". In accordance with 15A NCAC 02B .0505: "If no approved methods are determined capable of achieving detection and reporting levels below permit discharge requirements, then the approved method with the lowest detection and reporting level must be used." The Division's NPDES Unit would use the new water quality standard along with an NPDES facility's receiving stream 7Q10 to calculate a potential weekly average NPDES permit limit. The new "One-Half Final Acute Value" of 1.5

ug/l would be used without any receiving stream dilution to calculate a potential daily maximum NPDES limit. The most conservative of the potential limits would then be compared to effluent data from the NPDES facility, and any such facility with a reasonable potential to violate their limit would have that limit included in their NPDES permit. However, should effluent data be less than detectable levels or the PQL, no limit would be imposed. At this time, NPDES staff cannot speculate on the impact of implementation. As noted in a previous response, 13 out 18 laboratories surveyed can reach PQLs of 1 ug/l. The NPDES program will be working with various Division staff on implementation issues as further information becomes available.

- ***Comment**: Pretreatment Program Consequences: The use of the proposed water quality standard will result in over allocation at most municipal wastewater treatment plants (WWTPs) with Industrial Pretreatment Programs with JUST the cadmium coming from domestic sources. Impact to industrial processing plants with pretreatment permits to discharge their wastewater into the municipal WWTPs will be restrictive – due to the facilities inability to control trace amounts of Cadmium from being discharged to the receiving WWTP. The NC Pretreatment Consortium request that staff work with DWQ's Pretreatment staff to evaluate procedures that do not penalize industrial contributors for allocation assumptions when the standard and majority of the analytical data is below detectable levels*

Response: The Division staff has considered the issue of potential over allocation of Cadmium at Pretreatment municipal NPDES facilities, with information provided as follows:

- Cadmium is very pervasive in industrial societies and thus in wastewater. It is found in innumerable products such as industrial and consumer batteries, pigments, plastic stabilizers (notably in PVC), metal alloys used in copper wire, a significant contaminant in fertilizers, a trace pollutant in many more products, and is even present in plant and animal tissue. This pervasiveness may make source reduction less effective than it has been for other pollutants.

- A preliminary comparison of Industrial User data from one POTW using typical composite sampling procedures shows all of their metals finishers have detectable levels of cadmium, even those with significant metals removal on-site. However, another POTW using clean sampling techniques for their composite sampling indicated that their metals finishers are always below detection, although some of their other industries, such as a commercial laundry, had significant levels of cadmium. Clean sampling techniques will be invaluable for proper identification and calculation of accurate cadmium loading

- Pretreatment WWTP sampling using the current 2 ug/l PQL usually produces all "below detection" data, resulting in an inability to calculate a site-specific removal rate. In this case, DWQ allows POTWs to use the EPA median literature removal rate of 67%. Review of WWTP data for selected Pretreatment POTWs currently using a lower PQL still shows most data is below detection; therefore it is likely that most NC POTWs would still use the 67%. At the current NC WQS of 2 ug/l and the "worst case" NPDES limit of 2 ug/l (7Q10 = 0), 67 % removal gives an allowable influent of 6 ug/l. With EPA published typical residential/commercial cadmium load of 3 ug/l, there is still sufficient allowable load left for industries. If the recalculated cadmium standard of 0.27 ug/L were used, the "worst case" NPDES limit of 0.27 ug/l would give an allowable influent of 0.8 ug/l for all sources, which results in nothing left for industries if the residential/commercial influent is 3 ug/l. The "best case" NPDES limit would be 1.5 ug/l (see above comment on NPDES permits), resulting in an allowable influent of 4.5 ug/l. DWQ estimates at least one-half or more of the Pretreatment POTWs would have potential NPDES limits lower than that, using currently available data.

- Review of selected domestic/commercial data using the lower PQLs show the domestic/commercial load is significantly lower than the literature of 3 ug/l. With an allowed influent of 0.8 ug/l, a domestic/commercial influent of 0.5 ug/l could generate a small Allowable Industrial Load for some POTWs.

Supporting Comments From:

The City of Burlington

US Fish and Wildlife Service

North Carolina Conservation Network

Environment North Carolina

Southern Environmental Law Center

Clean Water for North Carolina

Comment: *Representatives writing on behalf of the City of Burlington provided written comments to the proposed cadmium standard which included those noted above and these additional recommendations and comments: (1) The City indicated that a more effective approach to protecting aquatic systems and the environment would be implementation of an effective recycling program. (2) The City requested that mandatory use of alternative fuels should be considered.*

Response: Staff appreciates these valuable suggestions and has passed them on to the Division of Pollution Prevention and Environmental Assistance.

Comment: *Support for revision of the cadmium standard was received from the US Fish and Wildlife Service (USFWS). Additionally, the service submitted data to support the reduction in the applicable Practical Reporting Limit (PQL), stating that five laboratories contracted for work by the Service could establish a Method Detection Limit (MDL) of below the stated proposed standard of 0.16 ug/L. Analytical methods employed were indicated as graphite furnace atomic absorption or ICP/MS.*

Response: Information supplied by the Service was used in the analysis of potential PQL derivation. A summary of that information is supplied as Attachment A-12 and supports a reduction in the required PQL from 2 ug/L to a level between 0.5 ug/L and 1 ug/L. Staff appreciates the additional information and is grateful for the supporting laboratory information supplied by the Service.

Comment: *Support for revision of the cadmium standard was received from North Carolina Conservation Network and Environment North Carolina citing in their comments the potential adverse effects to aquatic species including behavior, growth and physiological problems. They stated concern over adverse effects to humans eating contaminated fish and shellfish and the compounding effects to human from consumption of high levels of Cadmium from fish intake and contaminated drinking water supplies.*

Response: While EPA has compiled cadmium bioaccumulation data in their 2004 document, they have not developed a final residue value from which to develop a cadmium water quality standard.

Comment: *Support for the standard revision was received from the Southern Environmental Law Center.*

Comment: *Support for revision of the cadmium standard was received from Clean Water for North Carolina.*

Response: The Division appreciates the cooperation and efforts of these agencies.

2. Trialkyltin compounds (expressed as Tributyltin) Comments

Proposed Revised Aquatic Life Standard:	**0.072 ug/L**
Current Aquatic Life Standard:	0.008 ug/L
Proposed Revised *Saltwater* Aquatic Life Standard:	**0.007 ug/L**
Current *Saltwater* Aquatic Life Standard:	0.002 ug/L

Comment: *Opposition for the proposed standard revision was received from the Southern Environmental Law Center, Clean Water for North Carolina, North Carolina Conservation Network and Environment North Carolina citing in their comments the potential adverse effects to reproductive and developmental processes in freshwater and saltwater aquatic species. Concern for the potential endocrine disruption properties of Trialkyltin was also voiced.*

Comment: *The United States Fish and Wildlife Service submitted comments supporting the US EPA's Ambient Water Quality Criteria for Tributyltin research – but, expressed the opinion that they would also support leaving the standard unchanged.*

Response: Tributyltin is an organotin compound that was used primarily as a biocide in antifouling paints. It is extremely toxic to aquatic life and is an endocrine-disrupting chemical that causes severe reproductive effects in aquatic organisms. As noted by the comments received, Tributyltin is extremely stable and resistant to natural degradation in water. Because of its chemical properties and widespread use as an antifouling agent, concerns were raised over the risks it poses to both freshwater and saltwater organisms. The US EPA revised and published its final ambient water quality criteria document for Tributyltin in January of 2004 that contains criteria designed to protect aquatic organisms and their uses. These Tributyltin water quality criteria were published pursuant to Section 304(a) of the Clean Water Act (CWA) and have provided information that provides for the proposed criteria levels for Trialkyltin (as tributyltin).

The current Tributyltin standard (established by the EMC in the early 1980's) was originally adopted to due to toxicity related to its use as a biocide in the manufacture of socks. Many textile industries were adding it to socks to prevent foot odor, however, the biocide was extremely toxic to the aquatic life and was responsible for the death of a number of cows downstream from one such facility. In the 80's, it was also discovered that it was being used as a biocide in industrial cooling water processes. Larger ships in marine waters are currently the predominate source of the chemical in marine waters, as it is used on the undersides of the ships to prevent barnacles from attaching to the hull. It is no longer used on a vessel smaller than 65 feet or pleasure craft. Because of the difficulty in controlling the compound, industries have virtually eliminated its use in NC.

The current standard was based on very limited draft guidance and data available at the time. This number was calculated using and incorporating numerous uncertainty /safety factors to assure adequate aquatic life protection. The proposed revised criterion is based on the most current literature and science.

3. Human Health Calculation Factors: Fish Consumption Rate (FCR) Comments

Proposed Revised FCR:	**17.5 grams/person/day**
Current FCR:	6.5 grams/person/day

Comment: *A representative for the City of Graham opposed the proposed change stating that the change indicated a 270% increase in consumption of North Carolina fish and shellfish. The representative indicated that a survey of seafood content in his personal home freezer indicated that the seafood originated out of the State.*

Response: The EPA's adoption of 17.5 grams/person/day as the Fish Consumption Rate for use in developing National Water Quality Criteria was based on extensive data and review including the US Department of Agriculture's "Continuing Survey of Food Intakes by Individuals" (CSFII). This three-year survey included the intake of fish/shellfish from both marine and freshwaters and statistically evaluated the consumption patterns across various populations and geographical regions of the US. To put this increase in context of actual consumption, the current rate assumes that a North Carolinian consumes 1.6 ounces of fish per person per week (about 6.4 ounces per month or one meal). The proposed increase in this factor assumes that the average consumption of fish and shellfish is approximately 4.32 ounces per person per week (about 17 ounces per month or around 3 meals). This increased fish consumption rate is supported by the increased marketing of North Carolina seafood and fish and is protective of recreational fishers.

Comment: *Commendation and support for the FCR revision was received from the Southern Environmental Law Center and from Clean Water for North Carolina.*

Response: No response necessary.

Comment: *Support for revision of three pollutants: Heptachlor, Hexachlorobutadiene and Trichloroethylene was supplied by North Carolina Conservation Network and Environment North Carolina citing in their comments the potential adverse effects to human health from exposure.*

Response: These compounds were revised to include the updated FCR. No additional response required.

Comment: *Regarding the proposal to establish allowable levels of tetrachloroethylene of 3.3 µg/L for protection of human health through the consumption of fish and shellfish and 0.7 µg/l for protection of human health from water consumption, the Halogenated Solvents Industry Alliance, Inc. (HSIA) believes that it is inappropriate to establish standards for perchloroethylene based on carcinogenicity; in light of a recently published study suggesting that the solvent does not cause cancer in humans.*

Response: As stated above, the Division's primary reference for surface water quality standard development is the EPA's National Recommended Water Quality Criteria (2006) and National Recommended Water Quality Criteria and Human Health Criteria Calculation Matrix (2002) documents. When information is not available through this resource, as with Beryllium, information regarding standard development is obtained through EPA's Integrated Risk Information System (IRIS), a database containing chemical-specific Reference Doses (RfDs) and cancer risk estimates. The surface water standards for tetrachloroethylene are based on EPA's National Recommended Water Quality Criteria (2006) for the chemical and include the proposed revised national default Fish Consumption Rate (FCR). These values are based on the carcinogenic effects of the compound, and were calculated in EPA's 1980 Ambient Water Quality Criteria Document for Tetrachloroethylene (see 65 FR 66443 for EPA's revised methodology for calculating ambient water quality criteria).

As noted in the comment, EPA is currently updating its evaluation of tetrachloroethylene (perchloroethylene) in IRIS. Currently, there is an RfD, but no cancer assessment for tetrachloroethylene in IRIS. The two papers submitted by the commenter, Mundt et al., 2003 and Lynge et al., 2006, are valuable contributions to the overall weight of evidence on the carcinogenicity of the compound. However, at this time, after consultation with the US EPA Office of Water, they have deemed it is not appropriate to discount the potential carcinogenic effects of tetrachloroethylene. Several prominent international and national organizations have evaluated the carcinogenicity of tetrachloroethylene. The International Agency for Research on Cancer (IARC) currently finds sufficient evidence to designate tetrachloroethylene as carcinogenic in animals, with limited evidence in humans. The National Toxicology Program (NTP) 11th Report on Carcinogens (2004) classifies perchloroethylene as "reasonably anticipated to be a human carcinogen" based on sufficient evidence of carcinogenicity in experimental animals.

Therefore, at this time we believe it is appropriate to apply the revised FCR and to continue to base the surface water standards for tetrachloroethylene on its potential carcinogenic effects. If EPA's evaluation of tetrachloroethylene results in a finding that the noncarcinogenic effects of the chemical are the most sensitive endpoint, we will propose revision of the surface water standards accordingly.

4. Enterococci Standard Comments

Proposed: **Enterococci indicator for Class SC, SB and SA waters**
Fecal Coliform indicator for Class SA waters (dual indicator) –no change

Current: Fecal Coliform in Class SC, SB and SA

Comment: *Representatives from Clean Water for North Carolina (CWFNC) and a private citizen, Marilyn Grolitzer, supported revisions to the coastal bacteria indicator from the current fecal coliform standard to the proposed enterococci standard.*

Response: No response required.

5. Beryllium Comments

Proposed Revised Human Health Standard:	**no standard; Removal of current standard**
Current:	
Human Health – organism only	0.117 ug/L
Water Supply – organism + water consumption	0.0068 ug/L
Current Aquatic Life Standard:	6.5 ug/L

Comment: *Duke Energy Corporation and Progress Energy Service Company, LLC recommended omitting all standards for Beryllium, but acknowledged that a standard may be appropriate for Water Supply classified waters. Indicating that the standard, if applied, should be consistent with the federal drinking water level of 0.004 mg/L (4 ug/L). Duke Energy Corporation and Progress Energy Service Company, LLC further stated that no national water quality criteria are recommended by the US EPA. Progress Energy Service Company, LLC cited that the existing human health criterion is likely based upon the US EPA's 1986 guidance for human health protection for Beryllium, which has been updated.*

Comment: *Clean Water for North Carolina voiced opposition to weaker limits for Beryllium.*

Comment: *Opposition for revision of the Beryllium standard was received from North Carolina Conservation Network and Environment North Carolina citing in their comments the potential adverse effects to aquatic species including developmental problems in salamanders. They stated concern over adverse effects to humans from recreational use exposure e(dermal).*

Response: The proposal to remove Beryllium as a human health standard (applicable to Water Supply waters and Class C waters) is in direct response to an EPA action (April 1998) that removed the oral carcinogenic potency factors (CPF) from the Integrated Risk Information System (IRIS) database (Attachment A-6). Beryllium has been identified by the US EPA IRIS database (2/2007) as a known carcinogen through the inhalation route only. No current carcinogen data exists to support the calculation of a human health protective level for cancer by the oral/ingestion route. Previously, the EPA had provided a Cancer Potency Factor that was used in the human health protection calculations (US EPA National Recommended Water Quality Criteria, 1998). With the removal of the CPF for Beryllium by oral/ingestion route of exposure, Beryllium cannot be classified under the 02B regulations as a carcinogen Recalculation to protect human health from non-cancer endpoints provides a number that is higher than the current aquatic life concentration (Using the IRIS RfD of 2E X 10^{-6} , the resulting Water Supply standard is 60 ug/L and the human health standard is 420 ug/L.) The current Aquatic Life standard is 6.5 ug/L and will be protective of both human health and aquatic life. The US EPA Region IV staff was contacted regarding this proposal and indicated that they would not object to the removal – citing that EPA has not provided any additional human health information on which to base a scientific recalculation. The Environmental Management Commission established the current aquatic life standard in 1989, historical records of the proceeding indicate no discussion or adverse comments received.

If EPA's evaluation of beryllium results in a finding that the carcinogenic effects of the chemical by the oral route of exposure are the most sensitive endpoint, we will propose revision of the surface water human health standards accordingly.

6. Dissolved Oxygen Standard in Class SC Waters

Proposed: **No changes were proposed**

Current standard: "not less than 5.0 mg/L, except swamp waters, poorly flushed tidally influenced streams or embayments, or estuarine bottom waters may have lower values if caused by natural conditions"

Comment: *Opposition for the existing DO standard was received from the City of Wilmington and International Paper with specific emphasis as to the impairment decisions made from interpretation of the existing standard and the Total Maximum Daily Load (TMDL) development required by those designated impairments. A representative of the City of Wilmington also voiced these objections at the Wilmington, NC public hearing. Both the City of Wilmington and*

International Paper support a revision to the standard based upon a recent US EPA "Ambient Aquatic Life Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hatteras"; November 2000 (EPA 822-R-00-012).

Response: The suggested US EPA criteria reference document recommendations apply to coastal waters (defined as within three miles from shore under section 502(8) of the CWA) of the Virginian Province (Cape Cod, MA to Cape Hatteras, NC) of the Atlantic coast of the United States. States can apply the criteria to other coastal waters if they can scientifically determine that their location-specific biological, physical, and water quality conditions are comparable to those of the Virginian Province. While the Division does not dismiss EPA's study on DO concentrations in the Virginian Province, it should be noted that Cape Hatteras is north of the Lower Cape Fear River Estuary and the criteria may or may not be applicable. That being said, the Division welcomes any supporting information and data supplied by International Paper that is specific to site conditions.

7. Color Standard Comments Received

Proposed change to this rule: **Correction to the 40 CFR reference, as there is an identified typographical error.**

Current standard: "Oils; deleterious substances; colored or other wastes: only such amounts as shall not render the waters injurious to public health, secondary recreation or to aquatic life and wildlife or adversely affect the palatability of fish, aesthetic quality or impair the waters for any designated uses; for the purpose of implementing this Rule, oils, deleterious substances, colored or other wastes shall include but not be limited to substances that cause a film or sheen upon or discoloration of the surface of the water or adjoining shorelines pursuant to 40 CFR 110.4(a)-(b) which are hereby incorporated by reference including any subsequent amendments and additions."

Comment: *A representative from Blue Ridge Paper Products, Inc requested copies of any comments received with respect to the color variance.*

Response: These were delivered per request.

Comment: *Representatives from Clean Water for North Carolina (CWFNC) and a private citizen Marilyn Grolitzer, supported revisions to the narrative color standard stating that North Carolina's current narrative standards for color do not hold polluting facilities accountable for the impacts of their discharges. CWFNC suggested that a numerical standard for color should be adopted with a maximum acceptable color of 25 color units, basing the statement on color units applicable to "source water for the petroleum industry". CWFNC submitted a detailed methodology for the establishment of a numeric site-specific water quality standard and compliance method.*

Response: A statewide, narrative surface water quality standard for color has already been established and approved by the US EPA. North Carolina has narrative standards rather than numerical standards for color for the same reasons that the US EPA has never attempted to do so.

According to the US EPA current criteria (2006)– "Color results in water from the degradation processes in the natural environment. Because there is no general agreement as to the chemical composition of natural color, and in fact, the composition may vary chemically from place to place, the natural colors of the waters in the state can differ dramatically due to the geology of the area through which the water flows and the type of vegetation native to the particular area of the state. Narrative standards allow for the natural variation in the colors of the water to be considered in an evaluation of color changes due to discharges." The current standard has allowed DWQ to effectively regulate colored discharges in the past on a site-specific basis and to reduce nuisance color in surface waters.

8. Mixing Zones

No proposed changes to the applicable rule.

Comment: *CWFNC remarked that the presence of mixing zones was "an abdication" of the Division's responsibility to set discharge limits that are fully protective at the point of discharge.*

Response: The DWQ NPDES Permitting Unit generally does not allow for mixing zones in discharge permits. Those mixing zones that are granted are provided on a case-by-case basis after a thorough examination of the data and approved mixing zone model. All mixing zones provide for acute and chronic protection as specified in 15A NCAC 02B .0204 (b).

9. Methyl tertiary-butyl ether (MTBE) Comments

No standard proposed.

Comment: *Clean Water for North Carolina (CWFNC), Environment North Carolina and the North Carolina Conservation Network encouraged establishment of a standard for MTBE in surface waters.*

Response: In October 2002, the EMC considered adoption of an MTBE standard recommended during the 2000-2003 Triennial Review. The EMC believed that the MTBE data presented at that time did not provided sufficient evidence to determine the appropriate carcinogenicity of the compound. They requested staff to continue to review the literature and inform them of any revised criteria provided through the appropriate data resources. The detailed Tracking report for IRIS Chemical Assessment lists a 3/28/2007 date for the Agency review of this chemical (Attachment A-13). No additional data has emerged for staff to bring forward to the EMC. The Division agrees that establishing a surface water standard for MTBE is advisable; staff plans to monitor carefully the on-going activities of the US EPA in this area, with the purpose of proposing a numerical standard for MTBE.

10. Conductivity

No standard proposed.

Comment: *Representatives from Clean Water for North Carolina (CWFNC) and a private citizen Marilyn Grolitzer, indicated that North Carolina needs a state standard for conductivity. Conductivity is useful as a general measure of stream quality and to detect how many impurities are dissolved in the water. A state standard should be set restricting facilities that discharge to a given waterway to elevating conductivity levels to no more than 200% of the average upstream levels (i.e., no more than 100% increase above the upstream average).*

Response: Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions or sodium, magnesium, calcium, iron, and aluminum cations. Conductivity in streams and rivers is affected primarily by the geology of the area through which the water flows, with streams that run through areas with granite bedrock tending to have lower conductivity than streams that run through areas with clay soils. The Division agrees that conductivity can be used as a general measure of stream water quality. However, we don't believe that a state standard needs to be set for conductivity because standards already exist for surface waters within water supply watersheds for total dissolved solids (500 mg/L) and total hardness (100 mg/L as calcium carbonate), which both measure the same type of water quality parameters as does conductivity.

11. Radioactivity

No proposed changes to standard.

Comment*: Representatives from Clean Water for North Carolina (CWFNC) and a private citizen, Marilyn Grolitzer, indicated concern that discharge limits for radioactivity have not been specified in NPDES permits and they are not specified in the monitoring parameters of the NPDES permits for nuclear power plants. North Carolina's standards for radioactivity must be implemented through monitoring requirements and public reporting.*

Response*:* Radioactivity, with respect to Nuclear Power Plants, is regulated by the Nuclear Regulatory Commission (NRC). 40 CFR Part 122.2 exempts sampling of certain radiological parameter for NPDES permits, as they are covered by NRC regulations. For other radiological parameters, if components are found to be parameters of concern in other types of discharges, they are subject to monitoring or limits in NPDES permits as is necessary.

12. Ammonia Comments

No standard proposed.

Comment: *Clean Water for North Carolina, Southern Environmental Law Center, and the United States Fish and Wildlife Service (Service) supported the proposal of a standard for ammonia to better protect aquatic life, particularly mussels. An attached article (Augspurger et al. 2003) shows that there is sufficient data to support revision of U.S. EPA acute ammonia criteria or the establishment of North Carolina water quality standards for acute exposure*

Response**:** EPA is currently reevaluating the aquatic life criteria for ammonia, including work introduced by Augspurger and others. In July 2004, EPA published a Federal Register Notice announcing its intent to reevaluate the ammonia aquatic life criteria and requesting additional data, especially pertaining to mussel toxicity. In August 2005, EPA held a public workshop at which experts from academia, the U.S. Fish and Wildlife Service, and the U.S. Geological Survey presented their research on mussel toxicity testing. After that workshop, EPA funded additional research to answer questions in the criteria reevaluation process and they plan to make a decision on whether or not to revise the aquatic life criteria for ammonia by (originally) the end of 2006. After EPA makes its decision, we will reexamine the standard, requesting the valued assistance of the Service, and determine an appropriate course of action.

13. Manganese Comments

No proposed changes

Current Standard: 200 ug/L (Water Supply Classified Waters only)

Comment: *Representatives from Clean Water for North Carolina (CWFNC) and Marilyn Grolitzer, indicated that North Carolina needs a state standard for Manganese. Manganese is a very toxic compound, causing neurotoxic effects, including learning difficulties in children consuming high levels of manganese in their drinking water. Higher levels of manganese are now being found in groundwater and surface water in the state. North Carolina should adopt a stricter limit on manganese than the current level of 200 µg/L; the level should be brought in line with the current EPA recommended level of 50 µg/L.*

Response: The current water quality standard for manganese in surface water within water supply watersheds is 200 µg/L. This level is based on the fact that natural background levels of manganese are quite high in North Carolina, with average levels in streams ranging from 400 to 2,400 µg/L, with a statewide average of 810 µg/L. A review of data collected from water supply lakes sampled by DWQ found 22 samples out of 2287 (1%) above 200 ug/L. Since manganese is easily removed by conventional drinking water treatment, such as coagulation and oxidation, there is no problem with water treatment facilities removing manganese to the secondary maximum contaminant level (SMCL) of 50 µg/L for manganese (the recommended level in drinking water based on aesthetic considerations).

Manganese is a naturally occurring compound, with high levels found naturally in water bodies such as lakes, rivers, and streams. Plants and humans require a certain amount of manganese in their systems. In waters with high plant related organic inputs, manganese can be released due to chemical changes in the water column and sediments.

In humans, it is an essential element that plays a role in bone mineralization, protein and energy metabolism, and metabolic regulation. An adequate level for nutrition is considered to be 1-10 mg/day, with this level provided through a normal intake of food. However, as stated by the commenter, high levels of manganese can cause adverse health effects. The major effects through inhalation exposure are on the lungs, central nervous system, and reproductive system. Manganism is a disease that has been seen in workers exposed to very high levels of manganese through inhalation exposure. Manganism is similar to Parkinson's disease; it affects the central nervous system causing motor deficits, tremors, muscle problems, and occasionally psychiatric disturbances.

A study provided by the commenter shows the potential for adverse health effects from showering in manganese-contaminated water for more than a decade. This is an interesting study that was conducted by reviewing the medical literature and calculating, based on animal studies, the amount of manganese people would absorb by showering 10 minutes a day. However, this study, and the other literature provided by the commenter, does not support the conclusion that the surface water standard for manganese within water supply watersheds should be changed from the current level of 200 µg/L to 50 µg/L. Since manganese is easily removed by water treatment, reducing the surface water standard would not result in a reduction of exposure to manganese through drinking water or showering. In addition, since the primary toxic effects from manganese exposure result from inhalation exposure, not from ingestion exposure, reducing the standard would not present a benefit to public health.

14. Mercury Comments

Current Standard	12 ng/L
Current Saltwater Standard	25 ng/L

No proposed changes

Comment: *Clean Water for North Carolina indicated that Mercury needs to be monitored in sediments in order to track its impact on the aquatic environment. There must be a goal of zero discharge in all permits and a concentration of zero in the water column. North Carolina must aggressively pursue the setting and implementation of inter-media standards for mercury.*

Response: The Division and the Department of Environment and Natural Resources agrees that mercury is an important contaminant in our environment. For the protection of aquatic life in surface water, the standard for mercury is 0.012 µ/L. This level was originally calculated from data to prevent ingestion of fish contaminated above an established safe level. In addition, there are state standards for mercury in ground water (1.05 µ/L), drinking water (2 µ/L), and mercury vapor in air (0.0006 mg/m3). Recent actions by the Environmental Management Commission further restrict the amount of mercury that can be discharged to the air.

Comment: *Southern Environmental Law Center, Environment North Carolina & North Carolina Conservation Network commented that a standard should be adopted for methylmercury based on fish tissue residue criterion. EPA finalized this criterion in 2001 and concluded that it is more appropriate to adopt a fish tissue residue criterion for methylmercury rather than a water column-based criterion because it integrates spatial and temporal complexity that affects methylmercury bioaccumulation. Methylmercury is a particular problem for pregnant women and women of childbearing age as it can cause neurological effects, such as attention and language deficits and impaired visual and motor function in children. People are primarily exposed to methylmercury be eating contaminated fish and shellfish and North Carolina has a fish consumption advisory for methylmercury in many species of fish*

Response: The Division agrees that methyl mercury is a toxic compound causing neurological effects and that this compound is of particular concern to pregnant women and women of child-bearing age. North Carolina currently regulates mercury in water through its surface water standard for the protection of aquatic life of 0.012 μg/L and through NPDES permits which limit the amount of mercury that can be released into water through point sources. As noted by the commenter, North Carolina has fish consumption advisories for mercury in many species of fish, these advisories are provided through a cooperative effort of the Department of Health and Human Services and the Division of Water Quality. In 2001, EPA issued a draft guidance for implementing an ambient water quality criteria of 0.3 mg methyl mercury/kg fish tissue wet weight. This was EPA's first issuance of a water quality criterion expressed as a fish and shellfish tissue value rather than as an ambient water column value. The main reason that North Carolina and other states have not moved to a fish tissue criterion is the lack of information on the proper way to use a fish tissue concentration to calculate an appropriate applicable concentration in water for developing NPDES permits.

Understanding this concern, in a 2001 Federal register announcement, the EPA stated its intent to develop guidance on implementing the criterion. Subsequently, EPA formed a workgroup of representatives from state environmental agencies, EPA Regions, and headquarters air and water programs to develop the draft guidance.

The draft guidance was issued by Federal register notice on August 9, 2006, entitled the Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion. This guidance generally consolidates existing guidance on water quality standards, TMDLs, and permits where relevant to mercury. The new aspect of the guidance is a suggested approach for implementing the new methylmercury criterion that does not necessarily result in all NPDES discharges reducing the level of mercury in the discharge. Instead, for NPDES discharges that contribute only a very small amount of the mercury to a watershed, the suggested approach consists of holding the discharges at current levels. This suggested approach mirrors current practice for wasteload allocations where point sources are only small contributors to the total loading in a watershed. This approach avoids the need for a site-specific bioaccumulation factor that can be costly to develop.

Because this guidance was issued in August 2006, staff could not present it during this iteration of the Triennial Review. It is the intent of the Division to carefully review the documents and determine applicability for use in the State.

15. Dioxin Comments

Proposed Standards:	**(Class C, SC and WS)**	**$5 X 10^{-9}$ ug/L**
Current Standards:	(Class C and SC) (Class WS)	$1.4 X 10^{-8}$ ug/L $1.3 X 10^{-8}$ ug/L

Comment: *Clean Water for North Carolina submitted that Dioxin should be regulated at nondetect in effluent including the permit condition that the most sensitive EPA approved analytical method be used. Dioxins in sediments must be monitored at least every 3 years and if the risk to aquatic and human health from fish consumption is not predicted to be at 1 x 10-6 for cancer within 5 years, the site must be added to the NPL for removal or active remediation.*

Response: Limits for dioxin in effluent in North Carolina are set in NPDES permits and are based upon the applicable water quality standard; the most sensitive method is required of all analyses. Monitoring for dioxins in sediments also must use the most sensitive methods with compliance based upon meeting the standard. Levels of dioxin have greatly decreased in North Carolina waters, with the levels in fish tissues below detection in most fish species, using the most sensitive EPA approved analytical method. Regarding the listing of sites on EPA's National Priorities List (NPL), under the Comprehensive Emergency Response, Compensation, and Liability Act (CERCLA), only abandoned sites (with no responsible party) with uncontrolled hazardous substance releases are eligible to be listed on the NPL. Sites that have NPDES permits and are regulated by the state are not eligible to be listed on the NPL. Additional question with respect to management of NPL sites should be directed to the Division of Waste Management.

16. Adsorbable Organic Halides (AOX)

No proposed standard.

Comment: *Clean Water for North Carolina (CWFNC) submitted comments that the industry cluster rules regulate adsorbable organic halides (AOX) in pulp mill effluents as a weight/weight ratio but this is inadequately protective of small waters and their protected uses. A rigorous AOX effluent-loading standard should be put in place that regulates these compounds instream at nondetect as well as "at the pipe".*

Response: North Carolina implements Adsorbable Organic Halide (AOX) limits in NPDES permits in response to EPA promulgated Federal effluent guidelines (58 FR 66078, Dec 17 1993). These Federal guidelines, known as the "Cluster Rules", are technology based limits for the Pulp and Paper industries and have been revised and modified several times since the 1993 Federal register notice. In 2006, the EPA reviewed the effluent guidelines for the Pulp and Paper industry and decided *not* to make any additional changes to the existing regulation.

No EPA criterion has been developed for AOX through the "National Recommended Water Quality Criteria" process. NC has no evidence to suggest that discharges of AOX result in, or create, a negative impact on the designated uses. Staff identified only one paper plant on a "small water" – a review of the records indicated that the plant has a long term average discharge of 202 lbs/day, which is about 7% of their AOX daily limit.

17. Reclassification Comments

Comment: *Clean Water for North Carolina (CWFNC) urged the Commission to remove the Class C classification for North Carolina's waters and require all waters of the State to meet Class B standards for primary recreation.*

Response: Class B and Class C waters both carry the same current numerical and narrative water quality standards. The use of the term "primary recreation" includes areas where swimming is known to occur on a frequent or organized basis, but does not change the applicable level of protection for those waters.

Comment: *CWFN submitted that isolated wetlands should be classified as follows: Class WL – Freshwater Wetlands – should denote areas that are wet for some or all of the year and support vegetation adapted to life in soils saturated with fresh water, restrictions should be implemented; Class SWL – Saltwater Wetlands – should denote areas which are wet for some or all of the year, and support vegetation adapted to life in soils saturated with salt water or brackish water, they should receive protections analogous to those of High Quality Water streams; Class UWL – Unique Wetlands – should serve as wetlands analogue of Outstanding Resource Waters (ORW), they should contain the same prohibition on new or expanded discharges and development controls as ORWs.*

Response: The Division of Water Quality believes that it can effectively enforce wetlands standards in any wetland in the State, even though that wetland may not be classified. The State would like to be able to go through and properly classify all the wetlands using all the wetlands classifications that are contained in DWQ rules, but this is an extremely lengthy process and due to the present cutbacks we do not possess the resources necessary to quickly accomplish this task. However, in 2006, DWQ staff was granted permission by the Environmental Management Commission to go to public hearings on thirty-three proposals to add the "Unique Wetlands" (UWL) classification to certain wetlands. These wetlands are inhabited by state or federally listed threatened or endangered species and the proposals are to go to Public hearings in the spring of 2007. DWQ staff , if the public hearings occur as planned, would request the Environmental Management Commission to approve and adopt those proposals in late summer of 2007. In the Fall of 2007, the UWL designations are predicted to become effective. Additional development of these classifications will continue.

18. Waters Impaired for Two or More Pollutants

Comment: *CWFNC stated that the Division was failing to list waters in accordance wit the Clean Water Act requirements to list for every "pollutant". They stated that North Carolina is failing to list water for more than one pollutant in several cases, with the result that improvement in the level of more pollutant may result in delisting a water before other pollutant impacts have been sufficiently reduced. This is particularly the case for pollutants for which North Carolina has not set numerical standards.*

Response: The Clean Water Act requires listings for failing to meet each water quality standard. According to the TMDL Unit staff, we have listed water in accordance with EPA protocol using independent applicability and using both narrative and numeric standards. By federal policy, a delisting does not occur until all standards are met. The Division of Water Quality constantly strives to ensure that all its water quality standards and programs fully comply with the Clean Water Act.

19. Variances

Comment: The CWFNC also provided detailed comments opposing the continuation of the temperature variance in Blue Ridge Paper Product's current NPDES Permit. These remarks note that, in the CWFNC's opinion, the variance is illegal because the existing temperature variance does not allow a balanced and indigenous species population to exist downstream of the discharge. Likewise, additional comments were received with respect to power plants with thermal discharges in the state.

Response: On September 14, 2006, the Biological Assessment Unit of the Environmental Sciences section reviewed Blue Ridge Paper Products Inc.'s Canton Mill " Balanced and Indigenous Species Study for the Pigeon River". This is a required Clean Water Act Section 316(a) demonstration. It was the opinion of the staff that the Blue Ridge report "supports the Master Rationale" presented and in accordance with the EPA, meets the definition of a Balanced and Indigenous Population (Attachment A-14). The remarks will be referred to DWQ's NPDES Permitting Unit for their further review and consideration during the permitting process.

Summary Table: Basis for Proposed Numeric Changes to the Surface Water Quality Standards 2004-2006 Triennial Review

Chemical	Classification	Current Standard (ug/L)	Proposed Standard (ug/L)	Basis For Change
Aldrin	WS	0.000127	0.00005	Updated Fish Consumption Rate (FCR) per EPA – from 6.5 to 17.5 grams/person-day
	HH	0.000136	0.00005	
Benzene	WS	1.19	1.19	Updated FCR to 17.5 grams/person-day IRIS[1] Updated Cancer Potency Factor from 2.9E-2 to 1.5E-2
	HH	71.4	51	
Beryllium	WS	0.0068	Removed	EPA no longer considers Beryllium a carcinogen – CPF Removed from IRIS Recalculated as non-carcinogen[2]
	HH	0.117	Removed	
Cadmium	AQ FW non-Tr	2	0.16	EPA Request based on National Ambient Water Quality Criterion of 0.16 ug/L[3]
	AQ Tr	0.4	Removed	Proposed Aquatic Life non-Trout standard is more stringent
Carbon Tetrachloride	WS	0.254	0.254	Updated FCR to 17.5 grams/person-day
	HH	4.42	1.6	
Chlordane	WS	0.000575	0.0008	
	HH	0.000588	0.0008	
Enterococci (geomean/100 mL)	HH SW	none	35 (N)	BEACH Act/Federally Promulgated[4]
DDT	WS	0.000588	0.0002	Updated FCR to 17.5 grams/person-day
	HH	0.000591	0.0002	
Dieldrin	WS	0.000135	0.00005	
	HH	0.000144	0.00005	
Dioxin	WS	1.30E-08	5.00E-09	
	HH	1.40E-08	5.00E-09	
Heptachlor	WS	0.000208	0.00008	
	HH	0.000214	0.00008	
Hexachlorobutadiene	WS	0.445	0.44[5]	
	HH	49.7	18	
Polychlorinated Biphenyls (PCB)-**total**	HH	0.000079	0.000064	
Tetrachloroethane (1,1,2,2)	WS	0.172	0.17	
	HH	10.8	4	
Tetrachloroethylene	WS	0.8	0.7	
	HH	none	3.3	
Trialkyltin (as Tributyltin)	AQ FW	0.008	0.072	Based upon National Ambient Water Quality Criterion Update 12/03[6]
	AQ SW	0.002	0.007	
Trichloroethylene	WS	3.08	2.5	Updated FCR to 17.5 grams/person-day
	HH	92.4	30	
Vinyl Chloride	WS	2	0.025	Updated FCR to 17.5 grams/person-day / Updated CPF (from 1.74E-2 to 1.4 LMS exposure from birth)[7]
	HH	525	2.4	

Footnotes, Codes, and Additional Information for Summary Table

AQ FW	Aquatic Life protection applies to all freshwaters– freshwaters are defined by 15A NCAC 02B .0100
AQ SW	Aquatic Life protection applies to all saltwater – saltwaters are defined by 15A NCAC 02B .0100
AQ Tr	Aquatic Life protection applies to all waters supplementally classified as Trout (Tr) – Tr is defined by 15A NCAC 02B .0100
WS	WS standards are applicable to all Water Supply Classifications. WS standards are based on the consumption of fish and water. See 15A NCAC 2B .0208 for applicable equations.
HH	Human Health Standards are based on the consumption of fish only unless dermal contact studies are available. Applicable to all fresh and saltwaters. See 02B .0208 for applicable equations.
(N)	Narrative description of limits or additional narrative language applicable to the standard- See 15A NCAC 02B . 0220
(FCR)	Fish Consumption Rate (g/person-day)
(CPF)	Cancer Potency Factor (mg/kg-day)

1. IRIS is the EPA's Integrated Risk Information System database. (Integrated Risk Information System (IRIS) http://www.epa.gov/iris/)
2. Equations in 15A NCAC 2B .0208.
3. The US EPA has published revisions of Ambient Aquatic Life Water Quality Criteria for Cadmium (EPA 822-R-01-001; April 2001). .
4. The Water Quality Bacteria indicator standard for saline waters (Class SA, SB and SC) will change in direct response to the federal Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000. The EPA has determined that, in saline waters, the use of enterococci as a bacterial indicator is a better predictor of potential gastrointestinal distress. Upon US EPA approval and removal of the current Federal promulgation, our current standard of fecal coliform will be removed in all saline waters except Class SA (shellfish waters). Shellfish waters are under the jurisdiction of both the EPA and the Food and drug Administration (FDA). The FDA believes that the fecal coliform indicator is better suited for the protection of human health from the consumption of contaminated shellfish. Waters classified as SA therefore will maintain dual indicators.
5. WS standard was revised to proper significant figures.
6. The US EPA has published revisions of Ambient Aquatic Life Water Quality Criteria for Tributyltin (EPA 822-R-03-031; December 2003)
7. Updated CPF to 1.4 LMS exposure from birth (EPA Human Health Criteria Calculation Matrix 2002)

RECOMMENDATIONS

Following a careful and comprehensive review of all the submitted written and oral comments, supporting data, and attachments to this record, the Hearing Officer makes the following recommendations to the North Carolina Environmental Management Commission:

1. That the EMC adopt the changes to the surface water quality standards as proposed in the Notice of Text with the exception of Cadmium (15A NCAC 2B .0211 (3)(l)(iii)). Based on the new data provided during the public hearings, the Hearing Officer recommends sending the Cadmium rule back to staff for further review. Those changes are incorporated into the proposed rule amendments beginning on page S-27 of this document. A quick reference table of the Notice of Text proposed changes is supplied on page S-23.

   The standard changes recommended for adoption are summarized below the order in which they appear in rule:

   - Language changes to include prohibition of mixing zones for point source dischargers in SB and SA waters.
   - Proposed changes to factors affecting human health criteria calculations including:
     - Change from the archaic use of "Dietary Intake" to the US EPA Relative Source Contribution (RSC) language and clarification of applicability and use
     - Change in the NC Fish Consumption Rate (FCR) of 6.5 g/person/day to the national default fish consumption rate of 17.5 g/person/day
     - Updates to standards with revised Cancer Potency Factors
     - Resulting revisions to 15 existing carcinogen standards applicable to Class C waters, removal of Beryllium from the carcinogen classification, and addition of Tetrachloroethylene to the list of known carcinogens.
     - Resulting revisions to 12 existing carcinogen standards applicable to all Class WS waters
     - Clarification to narrative language for Temperature to clearly denote that a listing of thermal variances will be available for public access.
   - Proposed changes to aquatic life protective standards for Tributyltin.
   - Proposed changes to the bacterial indicators for Saltwaters, resulting in dual indicators for Class SA waters.

2. That all the submitted comments regarding water quality and thermal variances be forwarded to the NPDES Permitting Unit of DWQ for further review and consideration by appropriate parties at the time of the next scheduled renewal of these variances.

15A NCAC 02B .0204 is proposed for amendment as follows:

15A NCAC 02B .0204 LOCATION OF SAMPLING SITES AND MIXING ZONES

(a) Location of Sampling Sites. In conducting tests or making analytical determinations of classified waters to determine conformity or nonconformity with the established standards, samples shall be collected outside the limits of prescribed mixing zones. However, where appropriate, samples shall be collected within the mixing zone in order to ensure compliance with in-zone water quality requirements as outlined in Paragraph (b) of this Rule.

(b) Mixing Zones. A mixing zone may be established in the area of a discharge in order to provide reasonable opportunity for the mixture of the wastewater with the receiving waters. Water quality standards will not apply within regions defined as mixing zones, except that such zones will be subject to the conditions established in accordance with this Rule. The limits of such mixing zones will be defined by the division on a case-by-case basis after consideration of the magnitude and character of the waste discharge and the size and character of the receiving waters. Mixing zones will be determined such that discharges will not:

(1) result in acute toxicity to aquatic life [as defined by Rule .0202(1) of this Section] or prevent free passage of aquatic organisms around the mixing zone;

(2) result in offensive conditions;

(3) produce undesirable aquatic life or result in a dominance of nuisance species outside of the assigned mixing zone;

(4) endanger the public health or welfare.

In addition, a mixing zone will not be assigned for point source discharges of fecal coliform organisms in waters classified "WS-II," "WS-III," "B," ~~"SB,"~~ or "SA." Mixing zones will not be assigned for point source discharges of enterococci in waters classified "SB" or "SA."For the discharge of heated wastewater, compliance with federal rules and regulations pursuant to Section 316(a) of the Federal Water Pollution Control Act, as amended, shall constitute compliance with Subparagraph (b) of this Rule.

History Note: *Authority G.S. 143-214.1;*
Eff. February 1, 1976;
Amended Eff. January1, 2007; October 1, 1989; February 1, 1986; September 9, 1979.

15A NCAC 02B .0208 is proposed for amendment as follows:

15A NCAC 02B .0208 STANDARDS FOR TOXIC SUBSTANCES AND TEMPERATURE

(a) Toxic Substances. The concentration of toxic substances, either alone or in combination with other wastes, in surface waters shall not render waters injurious to aquatic life or wildlife, recreational activities, public health, or impair the waters for any designated uses. Specific standards for toxic substances to protect freshwater and tidal saltwater uses are listed in Rules .0211 and .0220 of this Section, respectively. Procedures for interpreting the narrative standard for toxic substances and numerical standards applicable to all waters are as follows:

(1) Aquatic life standards. The concentration of toxic substances shall not result in chronic toxicity. Any levels in excess of the chronic value will be considered to result in chronic toxicity. In the absence of direct measurements of chronic toxicity, the concentration of toxic substances shall not exceed the concentration specified by the fraction of the lowest LC50 value that predicts a no effect chronic level (as determined by the use of acceptable acute/chronic ratios). If an acceptable acute/chronic ratio is not available, then that toxic substance shall not exceed one-one hundredth (0.01) of the lowest LC50 or if it is affirmatively demonstrated that a toxic substance has a half-life of less than 96 hours the maximum concentration shall not exceed one-twentieth (0.05) of the lowest LC50.

(2) Human health standards. The concentration of toxic substances shall not exceed the level necessary to protect human health through exposure routes of fish (or shellfish) tissue consumption, water consumption, or other route identified as appropriate for the water body.

(A) For non-carcinogens, these concentrations shall be determined using a Reference Dose (RfD) as published by the U.S. Environmental Protection Agency pursuant to Section 304(a) of the Federal Water Pollution Control Act as amended or a RfD issued by the U.S. Environmental Protection Agency as listed in the Integrated Risk Information System (IRIS) file or a RfD approved by the Director after consultation with the State Health director. Water quality standards or criteria used to calculate water quality based effluent limitations to protect human health through the different exposure routes are determined as follows:

(i) Fish tissue consumption:

WQS = ~~(RfD-DT)~~(RfD x RSC) x Body Weight / (FCR x BCF)

where:

WQS = water quality standard or criteria;

RfD = reference dose;

~~DT = estimated non-fish dietary intake (when available);~~RSC = Relative Source Contribution

FCR = fish consumption rate (~~assumed to be 6.5~~based upon 17.5 gm/person-day);

BCF = bioconcentration factor, or bioaccumulation factor (BAF), as appropriate.

BCF or BAF values are based on U.S. Environmental Protection Agency publications pursuant to Section 304(a) of the Federal Water Pollution Control Act as amended, literature values, or site specific bioconcentration data approved by the Commission or its designee; FCR values are average consumption rates for a 70 Kg adult for the lifetime of the population; alternative FCR values may be used when it is considered necessary to protect localized populations that may be consuming fish at a higher rate; RSC values , when made available through U.S. Environmental Protection Agency publications pursuant to Section 304(a) of the Federal Clean Water Pollution Control Act to account for non-water sources of exposure. May be either a percentage (multiplied) or amount subtracted, depending on whether multiple criteria are relevant to the chemical.

(ii) Water consumption (including a correction for fish consumption):

WQS = ~~(RfD-DT)~~(RfD x RSC) x Body Weight / [WCR+(FCRxBCF)]

where:

WQS = water quality standard or criteria;

RfD = reference dose;

~~DT = estimated non-fish dietary intake (when available);~~ RSC = Relative Source Contribution

FCR = fish consumption rate (~~assumed to be 6.5~~based upon 17.5 gm/person-day);

BCF = bioconcentration factor, or bioaccumulation factor (BAF), as appropriate;

WCR = water consumption rate (assumed to be two liters per day for adults).

To protect sensitive groups, exposure ~~may be~~is based on a 10 Kg child drinking one liter of water per day. Standards may also be based on drinking water standards based on the requirements of the Federal Safe Drinking Water Act [42 U.S.C. 300(f)(g)-1]. For non-carcinogens, specific numerical water quality standards have not been included in this Rule because water quality standards to protect aquatic life for all toxic substances for which standards have been considered are more stringent than numerical standards to protect human health from non-carcinogens through consumption of fish; standards to protect human health from non-carcinogens through water consumption are listed under the water supply classification standards in Rule .0211 of this Section; the equations listed in this Subparagraph shall be used to develop water quality based effluent limitations on a case-by-case basis for toxic substances that are not presently included in the water quality standards. Alternative FCR values may be used when it is considered necessary to protect localized populations that may be consuming fish at a higher rate;

(B) For carcinogens, the concentrations of toxic substances shall not result in unacceptable health risks and shall be based on a Carcinogenic Potency Factor (CPF). An unacceptable health risk for cancer shall be considered to be more than one case of cancer per one million people exposed (10-6 risk level). The CPF is a measure of the cancer-causing potency of a substance estimated by the upper 95 percent confidence limit of the slope of a straight line calculated by the Linearized Multistage Model or other appropriate model according to U.S. Environmental Protection Agency Guidelines [FR 51 (185): 33992-34003; and FR 45 (231 Part V): 79318-79379]. Water quality standards or criteria for water quality based effluent limitations are calculated using the procedures given in Subparagraphs (A) and (B) of this Rule. Standards to protect human health from carcinogens through water consumption are listed under the water supply classification standards in Rules .0212, .0214, .0215, .0216, and .0218 of this Section; standards to protect human health from carcinogens through the consumption of fish (and shellfish) only are applicable to all waters as follows:

(i) Aldrin: ~~0.136~~0.05 ng/l;
(ii) Arsenic: 10 ug/l;
(iii) Benzene: ~~71.4~~51 ug/l;
~~(iv) Beryllium: 117 ng/l;~~
(v) Carbon tetrachloride: ~~4.42~~1.6 ug/l;
(vi) Chlordane: ~~0.588~~0.8 ng/l;
(vii) DDT: ~~0.591~~0.2 ng/l;
(viii) Dieldrin: ~~0.144~~0.05 ng/l;
(ix) Dioxin: ~~0.000014~~0.000005 ng/l;
(x) Heptachlor: ~~0.214~~0.08 ng/l;
(xi) Hexachlorobutadiene: ~~49.7~~18 ug/l;
(xii) Polychlorinated ~~biphenyls:~~biphenyls (total of all identified PCBs and congeners): ~~0.079~~0.064 ng/l;
(xiii) Polynuclear aromatic ~~hydrocarbons:~~hydrocarbons (total of all PAHs): 31.1 ng/l;
(xiv) ~~(xiv)~~ Tetrachloroethane (1,1,2,2): ~~10.8~~4 ug/l;
(xv) Tetrachloroethylene: 3.3 ug/L;
~~(xv)~~(xvi) Trichloroethylene: ~~92.4~~30 ug/l;
~~(xvi)~~(xvii) Vinyl chloride: ~~525~~2.4 ug/l.

The values listed in Subparts (i) through ~~(xvi)~~(xvii) in Part (B) of Subparagraph (2) of this Rule may be adjusted by the Commission or its designee on a case-by-case basis to account for site-specific or chemical-specific information pertaining to the assumed BCF, FCR or CPF values or other data.

(b) Temperature. The Commission may establish a water quality standard for temperature for specific water bodies other than the standards specified in Rules .0211 and .0220 of this Section, upon a case-by-case determination that thermal discharges to these waters, that serve or may serve as a source or receptor of industrial cooling water provide for the maintenance of the designated best use throughout a reasonable portion of the water body. Such revisions of the temperature standard must be consistent with the provisions of Section 316(a) of the Federal Water Pollution Control Act as ~~amended~~amended. ~~and shall be noted in Rule .0218 of this Section.~~ A listing of existing thermal revisions shall be maintained and made available to the public by the Division.

History Note: *Authority G.S. 143-214.1; 143-215.3(a)(1);*
Eff. February 1, 1976;
Amended Eff. January1, 2007; April 1, 2003; February 1, 1993; October 1, 1989; January 1, 1985; September 9, 1979.

15A NCAC 02B .0211 is proposed for amendment as follows:

15A NCAC 02B .0211 FRESH SURFACE WATER QUALITY STANDARDS FOR CLASS C WATERS

General. The water quality standards for all fresh surface waters are the basic standards applicable to Class C waters. See Rule .0208 of this Section for standards for toxic substances and temperature. Additional and more stringent standards applicable to other specific freshwater classifications are specified in Rules .0212, .0214, .0215, .0216, .0217, .0218, .0219, .0223, .0224 and .0225 of this Section.

(1) Best Usage of Waters. Aquatic life propagation and maintenance of biological integrity (including fishing, and fish), wildlife, secondary recreation, agriculture and any other usage except for primary recreation or as a source of water supply for drinking, culinary or food processing purposes;

(2) Conditions Related to Best Usage. The waters shall be suitable for aquatic life propagation and maintenance of biological integrity, wildlife, secondary recreation, and agriculture; sources of water pollution which preclude any of these uses on either a short-term or long-term basis shall be considered to be violating a water quality standard;

(3) Quality standards applicable to all fresh surface waters:

(a) Chlorophyll a (corrected): not greater than 40 ug/l for lakes, reservoirs, and other waters subject to growths of macroscopic or microscopic vegetation not designated as trout waters, and not greater than 15 ug/l for lakes, reservoirs, and other waters subject to growths of macroscopic or microscopic vegetation designated as trout waters (not applicable to lakes and reservoirs less than 10 acres in surface area); the Commission or its designee may prohibit or limit any discharge of waste into surface waters if, in the opinion of the Director, the surface waters experience or the discharge would result in growths of microscopic or macroscopic vegetation such that the standards established pursuant to this Rule would be violated or the intended best usage of the waters would be impaired;

(b) Dissolved oxygen: not less than 6.0 mg/l for trout waters; for non-trout waters, not less than a daily average of 5.0 mg/l with a minimum instantaneous value of not less than 4.0 mg/l; swamp waters, lake coves or backwaters, and lake bottom waters may have lower values if caused by natural conditions;

(c) Floating solids; settleable solids; sludge deposits: only such amounts attributable to sewage, industrial wastes or other wastes as shall not make the water unsafe or unsuitable for aquatic life and wildlife or impair the waters for any designated uses;

(d) Gases, total dissolved: not greater than 110 percent of saturation;

(e) Organisms of the coliform group: fecal coliforms shall not exceed a geometric mean of 200/100ml (MF count) based upon at least five consecutive samples examined during any 30 day period, nor exceed 400/100ml in more than 20 percent of the samples examined during such period; violations of the fecal coliform standard are expected during rainfall events and, in some cases, this violation is expected to be caused by uncontrollable nonpoint source pollution; all coliform concentrations are to be analyzed using the membrane filter technique unless high turbidity or other adverse conditions necessitate the tube dilution method; in case of controversy over results, the MPN 5-tube dilution technique shall be used as the reference method;

(f) Oils; deleterious substances; colored or other wastes: only such amounts as shall not render the waters injurious to public health, secondary recreation or to aquatic life and wildlife or adversely affect the palatability of fish, aesthetic quality or impair the waters for any designated uses; for the purpose of implementing this Rule, oils, deleterious substances, colored or other wastes shall include but not be limited to substances that cause a film or sheen upon or discoloration of the surface of the water or adjoining shorelines pursuant to 40 CFR ~~110.4(a)-(b)~~110.3(a)-(b) which are hereby incorporated by reference including any subsequent amendments and additions. This material is available for inspection at the Department of Environment and Natural Resources, Division of Water Quality, 512 North Salisbury Street, Raleigh, North Carolina. Copies may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402-9325 at a cost of ~~thirteen dollars ($13.00).~~forty-five dollars ($45.00).

(g) pH: shall be normal for the waters in the area, which generally shall range between 6.0 and 9.0 except that swamp waters may have a pH as low as 4.3 if it is the result of natural conditions;

(h) Phenolic compounds: only such levels as shall not result in fish-flesh tainting or impairment of other best usage;

(i) Radioactive substances:

(i) Combined radium-226 and radium-228: the maximum average annual activity level (based on at least four samples collected quarterly) for combined radium-226 and radium-228 shall not exceed five picoCuries per liter;

(ii) Alpha Emitters: the average annual gross alpha particle activity (including radium-226, but excluding radon and uranium) shall not exceed 15 picoCuries per liter;

(iii) Beta Emitters: the maximum average annual activity level (based on at least four samples, collected quarterly) for strontium-90 shall not exceed eight picoCuries per liter; nor shall the average annual gross beta particle activity (excluding potassium-40 and other naturally occurring radio-nuclides) exceed 50 picoCuries per liter; nor shall the maximum average annual activity level for tritium exceed 20,000 picoCuries per liter;

(j) Temperature: not to exceed 2.8 degrees C (5.04 degrees F) above the natural water temperature, and in no case to exceed 29 degrees C (84.2 degrees F) for mountain and upper piedmont waters and 32 degrees C (89.6 degrees F) for lower piedmont and coastal plain waters. The temperature for trout waters shall not be increased by more than 0.5 degrees C (0.9 degrees F) due to the discharge of heated liquids, but in no case to exceed 20 degrees C (68 degrees F);

(k) Turbidity: the turbidity in the receiving water shall not exceed 50 Nephelometric Turbidity Units (NTU) in streams not designated as trout waters and 10 NTU in streams, lakes or reservoirs designated as trout waters; for lakes and reservoirs not designated as trout waters, the turbidity shall not exceed 25 NTU; if turbidity exceeds these levels due to natural background conditions, the existing turbidity level cannot be increased. Compliance with this turbidity standard can be met when land management activities employ Best Management Practices (BMPs) [as defined by Rule .0202 of this Section] recommended by the Designated Nonpoint Source Agency [as defined by Rule .0202 of this Section]. BMPs must be in full compliance with all specifications governing the proper design, installation, operation and maintenance of such BMPs;

(l) Toxic substances: numerical water quality standards (maximum permissible levels) for the protection of human health applicable to all fresh surface waters are in Rule .0208 of this Section; numerical water quality standards (maximum permissible levels) to protect aquatic life applicable to all fresh surface waters:

(i) Arsenic: 50 ug/l;

(ii) Beryllium: 6.5 ug/l;

(iii) Cadmium: 0.4 ug/l for trout waters and 2.0 ug/l for non-trout waters; attainment of these water quality standards in surface waters shall be based on measurement of total recoverable metals concentrations unless appropriate studies have been conducted to translate total recoverable metals to a toxic form. Studies used to determine the toxic form or translators must be designed according to the "Water Quality Standards Handbook Second Edition" published by the Environmental Protection Agency (EPA 823-B-94-005a) or "The Metals Translator: Guidance For Calculating a Total Recoverable Permit Limit From a Dissolved Criterion" published by the Environmental Protection Agency (EPA 823-B-96-007) which are hereby incorporated by reference including any subsequent amendments. The Director shall consider conformance to EPA guidance as well as the presence of environmental conditions that limit the applicability of translators in approving the use of metal translators.

(iv) Chlorine, total residual: 17 ug/l;

(v) Chromium, total recoverable: 50 ug/l;

(vi) Cyanide: 5.0 ug/l; unless site-specific criteria are developed based upon the aquatic life at the site utilizing The Recalculation Procedure in Appendix B of Appendix L in the Environmental Protection Agency's Water Quality Standards Handbook hereby incorporated by reference including any subsequent amendments;

(vii) Fluorides: 1.8 mg/l;

(viii) Lead, total recoverable: 25 ug/l; collection of data on sources, transport and fate of lead shall be required as part of the toxicity reduction evaluation for dischargers that are out of compliance with whole effluent toxicity testing requirements and the concentration of lead in the effluent is concomitantly determined to exceed an instream level of 3.1 ug/l from the discharge;

(ix) Mercury: 0.012 ug/l;

(x) Nickel: 88 ug/l; attainment of these water quality standards in surface waters shall be based on measurement of total recoverable metals concentrations unless appropriate studies have been conducted to translate total recoverable metals to a toxic form. Studies used to determine the toxic form or translators must be designed according to the "Water Quality Standards Handbook Second Edition" published by the Environmental Protection Agency (EPA 823-B-94-005a) or "The Metals Translator: Guidance For Calculating a Total Recoverable Permit Limit From a Dissolved Criterion" published by the Environmental Protection Agency (EPA 823-B-96-007) which are hereby incorporated by reference including any subsequent amendments. The Director shall consider conformance to EPA guidance as well as the presence of environmental conditions that limit the applicability of translators in approving the use of metal translators.

(xi) Pesticides:

(A) Aldrin: 0.002 ug/l;
(B) Chlordane: 0.004 ug/l;
(C) DDT: 0.001 ug/l;
(D) Demeton: 0.1 ug/l;
(E) Dieldrin: 0.002 ug/l;
(F) Endosulfan: 0.05 ug/l;
(G) Endrin: 0.002 ug/l;
(H) Guthion: 0.01 ug/l;
(I) Heptachlor: 0.004 ug/l;
(J) Lindane: 0.01 ug/l;
(K) Methoxychlor: 0.03 ug/l;
(L) Mirex: 0.001 ug/l;
(M) Parathion: 0.013 ug/l;
(N) Toxaphene: 0.0002 ug/l;

(xii) Polychlorinated ~~biphenyls:~~ biphenyls: (total of all PCBs and congeners identified) 0.001 ug/l;

(xiii) Selenium: 5 ug/l;

(xiv) Toluene: 11 ug/l or 0.36 ug/l in trout waters;

(xv) Trialkyltin compounds: ~~0.008~~0.07 ug/l expressed as tributyltin;

(4) Action Levels for Toxic Substances: if the Action Levels for any of the substances listed in this Subparagraph (which are generally not bioaccumulative and have variable toxicity to aquatic life because of chemical form, solubility, stream characteristics or associated waste characteristics) are determined by the waste load allocation to be exceeded in a receiving water by a discharge under the specified low flow criterion for toxic substances (Rule .0206 in this Section), the discharger shall monitor the chemical or biological effects of the discharge; efforts shall be made by all dischargers to reduce or eliminate these substances from their effluents. Those substances for which Action Levels are listed in this Subparagraph shall be limited as appropriate in the NPDES permit based on the Action Levels listed in this Subparagraph if sufficient information (to be determined for metals by measurements of that portion of the dissolved instream concentration of the Action Level parameter attributable to a specific NPDES permitted discharge) exists to indicate that any of those substances may be a causative factor resulting in toxicity of the effluent. NPDES permit limits may be based on translation of the toxic form to total recoverable metals. Studies used to determine the toxic form or translators must be designed according to "Water Quality Standards Handbook Second Edition" published by the Environmental Protection Agency (EPA 823-B-94-005a) or "The Metals Translator: Guidance For Calculating a Total Recoverable Permit Limit From a Dissolved Criterion" published by the Environmental Protection Agency (EPA 823-B-96-007) which are hereby incorporated by reference including any subsequent amendments. The Director shall consider conformance to EPA guidance as well as the presence of environmental conditions that limit the applicability of translators in approving the use of metal translators.

(a) Copper: 7 ug/l;

(b) Iron: 1.0 mg/l;

(c) Silver: 0.06 ug/l;

(d) Zinc: 50 ug/l;

(e) Chloride: 230 mg/l;

For purposes other than consideration of NPDES permitting of point source discharges as described in this Subparagraph, the Action Levels in this Rule, as measured by an appropriate analytical technique, per 15A NCAC 02B .0103(a), shall be considered as numerical ambient water quality standards.

History Note: Authority G.S. 143-214.1; 143-215.3(a)(1);
Eff. February 1, 1976;

Amended Eff. January 1, 2007; April 1, 2003; August 1, 2000; October 1, 1995; August 1, 1995; April 1, 1994; February 1, 1993.

15A NCAC 02B .0212 is proposed for amendment as follows:

15A NCAC 02B .0212 FRESH SURFACE WATER QUALITY STANDARDS FOR CLASS WS-I WATERS

The following water quality standards apply to surface waters within water supply watersheds that are classified WS-I. Water quality standards applicable to Class C waters as described in Rule .0211 of this Section also apply to Class WS-I waters.

(1) The best usage of WS-I waters are as follows: a source of water supply for drinking, culinary, or food-processing purposes for those users desiring maximum protection of their water supplies, waters located on land in public ownership, and any best usage specified for Class C waters.

(2) The conditions related to the best usage are as follows: waters of this class are protected water supplies within essentially natural and undeveloped watersheds in public ownership with no permitted point source dischargers except those specified in Rule .0104 of this Subchapter; waters within this class must be relatively unimpacted by nonpoint sources of pollution; land use management programs are required to protect waters from nonpoint source pollution; the waters, following treatment required by the Division of Environmental Health, shall meet the Maximum Contaminant Level concentrations considered safe for drinking, culinary, and food-processing purposes which are specified in the national drinking water regulations and in the North Carolina Rules Governing Public Water Supplies, 15A NCAC 18C .1500; sources of water pollution which preclude any of these uses on either a short-term or long-term basis shall be considered to be violating a water quality standard. The Class WS-I classification may be used to protect portions of Class WS-II, WS-III and WS-IV water supplies. For reclassifications occurring after the July 1, 1992 statewide reclassification, the more protective classification requested by local governments shall be considered by the Commission when all local governments having jurisdiction in the affected area(s) have adopted a resolution and the appropriate ordinances to protect the watershed or the Commission acts to protect a watershed when one or more local governments has failed to adopt necessary protection measures.

(3) Quality standards applicable to Class WS-I Waters are as follows:

(a) MBAS (Methylene-Blue Active Substances): not greater than 0.5 mg/l to protect the aesthetic qualities of water supplies and to prevent foaming;

(b) Nonpoint Source Pollution: none that would adversely impact the waters for use as a water supply or any other designated use;

(c) Organisms of coliform group: total coliforms not to exceed 50/100 ml (MF count) as a monthly geometric mean value in watersheds serving as unfiltered water supplies;

(d) Chlorinated ~~Phenolic~~phenolic compounds: not greater than 1.0 ug/l ~~(phenols)~~ to protect water supplies from taste and odor problems from chlorinated phenols;

(e) Sewage, industrial wastes: none except those specified in Subparagraph (2) of this Paragraph or Rule .0104 of this Subchapter;

(f) Solids, total dissolved: not greater than 500 mg/l;

(g) Total hardness: not greater than 100 mg/l as calcium carbonate;

(h) Toxic and other deleterious substances:

(i) Water quality standards (maximum permissible concentrations) to protect human health through water consumption and fish tissue consumption for non-carcinogens in Class WS-I waters:

(A) Barium: 1.0 mg/l;

(B) Chloride: 250 mg/l;

(C) Manganese: 200 ug/l;

(D) Nickel: 25 ug/l;

(E) Nitrate nitrogen: 10.0 mg/l;

(F) 2,4-D: 100 ug/l;

(G) 2,4,5-TP (Silvex): 10 ug/l;

(H) Sulfates: 250 mg/l;

(ii) Water quality standards (maximum permissible concentrations) to protect human health through water consumption and fish tissue consumption for carcinogens in Class WS-I waters:

(A) Aldrin: ~~0.127~~0.05 ng/1;

(B) Arsenic: 10 ug/l;

~~(C)~~Benzene: 1.19 ug/1;

~~(D)~~(C) ~~Beryllium: 6.8 ng/1;~~

~~(E)~~(D) Carbon tetrachloride: 0.254 ug/l;

~~(F)~~(E) Chlordane: ~~0.575~~0.8 ng/1;

~~(G)~~(F) Chlorinated benzenes: 488 ug/l;

~~(H)~~(G) DDT: ~~0.588~~0.2 ng/1;

~~(I)~~(H) Dieldrin: ~~0.135~~0.05 ng/1;

~~(J)~~(I) Dioxin: ~~0.000013~~0.000005 ng/l;

~~(K)~~(J) Heptachlor: ~~0.208~~0.08 ng/1;

~~(L)~~(K) Hexachlorobutadiene: ~~0.445~~0.44 ug/l;

~~(M)~~(L) Polynuclear aromatic ~~hydrocarbons:~~hydrocarbons (total of all PAHs): 2.8 ng/l;

~~(N)~~(M) Tetrachloroethane (1,1,2,2): ~~-0.172~~0.17 ug/l;

~~(O)~~(N) Tetrachloroethylene: ~~0.8~~0.7 ug/l;

~~(P)~~(O) Trichloroethylene: ~~3.08~~2.5 ug/l;

~~(Q)~~(P) Vinyl Chloride: ~~2~~0.025 ug/l.

History Note: *Authority G.S. 143-214.1; 143-215.3(a)(1);*

Eff. February 1, 1976;
Amended Eff. <u>January 1, 2007;</u> April 1, 2003; October 1, 1995; February 1, 1993; March 1, 1991; October 1, 1989.

15A NCAC 02B .0214 is proposed for amendment as follows:

15A NCAC 02B .0214 FRESH SURFACE WATER QUALITY STANDARDS FOR CLASS WS-II WATERS

The following water quality standards apply to surface waters within water supply watersheds that are classified WS-II. Water quality standards applicable to Class C waters as described in Rule .0211 of this Section also apply to Class WS-II waters.

(1) The best usage of WS-II waters are as follows: a source of water supply for drinking, culinary, or food-processing purposes for those users desiring maximum protection for their water supplies where a WS-I classification is not feasible and any best usage specified for Class C waters.

(2) The conditions related to the best usage are as follows: waters of this class are protected as water supplies which are in predominantly undeveloped watersheds and meet average watershed development density levels as specified in Sub-Items (3)(b)(i)(A), (3)(b)(i)(B), (3)(b)(ii)(A) and (3)(b)(ii)(B) of this Rule; discharges which qualify for a General Permit pursuant to 15A NCAC 2H .0127, trout farm discharges, recycle (closed loop) systems that only discharge in response to 10-year storm events and other stormwater discharges are allowed in the entire watershed; new domestic and industrial discharges of treated wastewater are not allowed in the entire watershed; the waters, following treatment required by the Division of Environmental Health, shall meet the Maximum Contaminant Level concentrations considered safe for drinking, culinary, and food-processing purposes which are specified in the national drinking water regulations and in the North Carolina Rules Governing Public Water Supplies, 15A NCAC 18C .1500; sources of water pollution which preclude any of these uses on either a short-term or long-term basis shall be considered to be violating a water quality standard. The Class WS-II classification may be used to protect portions of Class WS-III and WS-IV water supplies. For reclassifications of these portions of Class WS-III and WS-IV water supplies occurring after the July 1, 1992 statewide reclassification, the more protective classification requested by local governments shall be considered by the Commission when all local governments having jurisdiction in the affected area(s) have adopted a resolution and the appropriate ordinances to protect the watershed or the Commission acts to protect a watershed when one or more local governments has failed to adopt necessary protection measures.

(3) Quality standards applicable to Class WS-II Waters are as follows:

(a) Sewage, industrial wastes, non-process industrial wastes, or other wastes: none except for those specified in either Item (2) of this Rule and Rule .0104 of this Subchapter; and none which shall have an adverse effect on human health or which are not effectively treated to the satisfaction of the Commission and in accordance with the requirements of the Division of Environmental Health, North Carolina Department of Environment and Natural Resources; any discharger may be required upon request by the Commission to disclose all chemical constituents present or potentially present in their wastes and chemicals which could be spilled or be present in runoff from their facility which may have an adverse impact on downstream water quality; these facilities may be required to have spill and treatment failure control plans as well as perform special monitoring for toxic substances;

(b) Nonpoint Source and Stormwater Pollution: none that would adversely impact the waters for use as a water supply or any other designated use;

(i) Nonpoint Source and Stormwater Pollution Control Criteria For Entire Watershed:

(A) Low Density Option: Development density must be limited to either no more than one dwelling unit per acre of single family detached residential development (or 40,000 square foot lot excluding roadway right-of-way) or 12 percent built-upon area for all other residential and non-residential development in the watershed outside of the critical area; Stormwater runoff from the development shall be transported by vegetated conveyances to the maximum extent practicable;

(B) High Density Option: If new development exceeds the low density option requirements as stated in Sub-Item (3)(b)(i)(A) of this Rule, then engineered stormwater controls must be used to control runoff from the first inch of rainfall; new residential and non-residential development shall not exceed 30 percent built-upon area;

(C) Land within the watershed shall be deemed compliant with the density requirements if the following condition is met: The density of all existing development at the time of reclassification does not exceed the density requirement when densities are averaged throughout the entire watershed area at the time of classification;

(D) Cluster development is allowed on a project-by-project basis as follows:

(I) overall density of the project meets associated density or stormwater control requirements of this Rule;

(II) buffers meet the minimum statewide water supply watershed protection requirements;

(III) built-upon areas are designed and located to minimize stormwater runoff impact to the receiving waters, minimize concentrated stormwater flow, maximize the use of sheet flow through vegetated areas; and maximize the flow length through vegetated areas;

(IV) areas of concentrated development are located in upland areas and away, to the maximum extent practicable, from surface waters and drainageways;

(V) remainder of tract to remain in vegetated or natural state;

(VI) area in the vegetated or natural state may be conveyed to a property owners association; a local government for preservation as a park or greenway; a conservation organization; or placed in a permanent conservation or farmland preservation easement;

(VII) a maintenance agreement for the vegetated or natural area shall be filed with the Register of Deeds; and

(VIII) cluster development that meets the applicable low density option requirements shall transport stormwater runoff from the development by vegetated conveyances to the maximum extent practicable;

(E) A maximum of 10 percent of each jurisdiction's portion of the watershed outside of the critical area as delineated on July 1, 1993 may be developed with new development projects and expansions of existing development of up to 70 percent built-upon surface area in addition to the new development approved in compliance with the appropriate requirements of Sub-Item (3)(b)(i)(A) or Sub-Item (3)(b)(i)(B) of this Rule. For expansions to existing development, the existing built-upon surface area is not counted toward the allowed 70 percent built-upon surface area. A local government having jurisdiction within the watershed may transfer, in whole or in part, its right to the 10 percent/70 percent land area to another local government within the watershed upon submittal of a joint resolution and review by the Commission. When the water supply watershed is composed of public lands, such as National Forest land, local governments may count the public land acreage within the watershed outside of the critical area in calculating the acreage allowed under this provision. For local governments that do not choose to use the high density option in that WS-II watershed, each project must, to the maximum extent practicable, minimize built-upon surface area, direct stormwater runoff away from surface waters and incorporate best management practices to minimize water quality impacts; if the local government selects the high density development option within that WS-II watershed, then engineered stormwater controls must be employed for the new development;

(F) If local governments choose the high density development option which requires stormwater controls, then they shall assume ultimate responsibility for operation and maintenance of the required controls as outlined in Rule .0104 of this Subchapter;

(G) Minimum 100 foot vegetative buffer is required for all new development activities that exceed the low density option requirements as specified in Sub-Items (3)(b)(i)(A) and Sub-Item (3)(b)(ii)(A) of this Rule; otherwise a minimum 30 foot vegetative buffer for development activities is required along all perennial waters indicated on the most recent versions of U.S.G.S. 1:24,000 (7.5 minute) scale topographic maps or as determined by local government studies; nothing in this Rule shall stand as a bar to artificial streambank or shoreline stabilization;

(H) No new development is allowed in the buffer; water dependent structures, or other structures such as flag poles, signs and security lights, which result in only diminimus increases in impervious area and public projects such as road crossings and greenways may be allowed where no practicable alternative exists; these activities shall minimize built-upon surface area, direct runoff away from the surface waters and maximize the utilization of BMPs;

(I) No NPDES permits shall be issued for landfills that discharge treated leachate;

(ii) Critical Area Nonpoint Source and Stormwater Pollution Control Criteria:

(A) Low Density Option: New development is limited to either no more than one dwelling unit of single family detached residential development per two acres (or 80,000 square foot lot excluding roadway right-of-way) or six percent built-upon area for all other residential and non-residential development; Stormwater runoff from the development shall be transported by vegetated conveyances to the maximum extent practicable;

(B) High Density Option: If new development density exceeds the low density requirements specified in Sub-Item (3)(b)(ii)(A) of this Rule, then engineered stormwater controls must be used to control runoff from the first inch of rainfall; new residential and non-residential development density not to exceed 24 percent built-upon area;

(C) No new permitted sites for land application of residuals or petroleum contaminated soils are allowed;

(D) No new landfills are allowed;

(c) MBAS (Methylene-Blue Active Substances): not greater than 0.5 mg/l to protect the aesthetic qualities of water supplies and to prevent foaming;

(d) Odor producing substances contained in sewage or other wastes: only such amounts, whether alone or in combination with other substances or wastes, as will not cause taste and odor difficulties in water supplies which cannot be corrected by treatment, impair the palatability of fish, or have a deleterious effect upon any best usage established for waters of this class;

(e) Chlorinated ~~Phenolic~~phenolic compounds: not greater than 1.0 ug/l ~~(phenols)~~ to protect water supplies from taste and odor problems from chlorinated phenols;

(f) Total hardness: not greater than 100 mg/l as calcium carbonate;

(g) Total dissolved solids: not greater than 500 mg/l;

(h) Toxic and other deleterious substances:

(i) Water quality standards (maximum permissible concentrations) to protect human health through water consumption and fish tissue consumption for non-carcinogens in Class WS-II waters:

(A) Barium: 1.0 mg/l;
(B) Chloride: 250 mg/l;
(C) Manganese: 200 ug/l;
(D) Nickel: 25 ug/l;
(E) Nitrate nitrogen: 10 mg/l;
(F) 2,4-D: 100 ug/l;
(G) 2,4,5-~~TP:~~TP (Silvex): 10 ug/l;
(H) Sulfates: 250 mg/l;

(ii) Water quality standards (maximum permissible concentrations) to protect human health through water consumption and fish tissue consumption for carcinogens in Class WS-II waters:

(A) Aldrin: ~~0.127~~0.05 ng/l;
(B) Arsenic: 10 ug/l;
(C) Benzene: 1.19 ug/l;
~~(D) Beryllium: 6.8 ng/l;~~
(E) Carbon tetrachloride: 0.254 ug/l;
(F) Chlordane: ~~0.575~~0.8 ng/l;
(G) Chlorinated benzenes: 488 ug/l;
(H) DDT: ~~0.588~~0.2 ng/l;
(I) Dieldrin: ~~0.135~~0.05 ng/l;
(J) Dioxin: ~~0.000013~~0.000005 ng/l;
(K) Heptachlor: ~~0.208~~0.08 ng/l;
(L) Hexachlorobutadiene: ~~0.445~~0.44 ug/l;
(M) Polynuclear aromatic ~~hydrocarbons:~~hydrocarbons (total of all PAHs): 2.8 ng/l;
(N) Tetrachloroethane (1,1,2,2): ~~0.172~~0.17 ug/l;
(O) Tetrachloroethylene: ~~0.8~~0.7 ug/l;

(P) Trichloroethylene: ~~3.08~~2.5 ug/l;

(Q) Vinyl Chloride: ~~2~~0.025 ug/l.

History Note: *Authority G.S. 143-214.1; 143-215.3(a)(1);*
Eff. May 10, 1979;
Amended Eff. January1, 2007; April 1, 2003; January 1, 1996; October 1, 1995.

15A NCAC 2B .0215 is proposed for amendment as follows:

15A NCAC 02B .0215 FRESH SURFACE WATER QUALITY STANDARDS FOR CLASS WS-III WATERS

The following water quality standards apply to surface water supply waters that are classified WS-III. Water quality standards applicable to Class C waters as described in Rule .0211 of this Section also apply to Class WS-III waters.

(1) The best usage of WS-III waters are as follows: a source of water supply for drinking, culinary, or food-processing purposes for those users where a more protective WS-I or WS-II classification is not feasible and any other best usage specified for Class C waters.

(2) The conditions related to the best usage are as follows: waters of this class are protected as water supplies which are generally in low to moderately developed watersheds and meet average watershed development density levels as specified in Sub-Items (3)(b)(i)(A), (3)(b)(i)(B), (3)(b)(ii)(A) and (3)(b)(ii)(B) of this Rule; discharges that qualify for a General Permit pursuant to 15A NCAC 2H .0127, trout farm discharges, recycle (closed loop) systems that only discharge in response to 10-year storm events, and other stormwater discharges are allowed in the entire watershed; treated domestic wastewater discharges are allowed in the entire watershed but no new domestic wastewater discharges are allowed in the critical area; no new industrial wastewater discharges except non-process industrial discharges are allowed in the entire watershed; the waters, following treatment required by the Division of Environmental Health, shall meet the Maximum Contaminant Level concentrations considered safe for drinking, culinary, or food-processing purposes which are specified in the national drinking water regulations and in the North Carolina Rules Governing Public Water Supplies, 15A NCAC 18C .1500; sources of water pollution which preclude any of these uses on either a short-term or long-term basis shall be considered to be violating a water quality standard; the Class WS-III classification may be used to protect portions of Class WS-IV water supplies. For reclassifications of these portions of WS-IV water supplies occurring after the July 1, 1992 statewide reclassification, the more protective classification requested by local governments shall be considered by the Commission when all local governments having jurisdiction in the affected area(s) have adopted a resolution and the appropriate ordinances to protect the watershed or the Commission acts to protect a watershed when one or more local governments has failed to adopt necessary protection measures.

(3) Quality standards applicable to Class WS-III Waters are as follows:

(a) Sewage, industrial wastes, non-process industrial wastes, or other wastes: none except for those specified in Item (2) of this Rule and Rule .0104 of this Subchapter; and none which shall have an adverse effect on human health or which are not effectively treated to the satisfaction of the Commission and in accordance with the requirements of the Division of Environmental Health, North Carolina Department of Environment and Natural Resources; any discharger may be required by the Commission to disclose all chemical constituents present or potentially present in their wastes and chemicals which could be spilled or be present in runoff from their facility which may have an adverse impact on downstream water quality; these facilities may be required to have spill and treatment failure control plans as well as perform special monitoring for toxic substances;

(b) Nonpoint Source and Stormwater Pollution: none that would adversely impact the waters for use as water supply or any other designated use;

(i) Nonpoint Source and Stormwater Pollution Control Criteria For Entire Watershed:

(A) Low Density Option: Development density must be limited to either no more than two dwelling units of single family detached residential development per acre (or 20,000 square foot lot excluding roadway right-of-way) or 24 percent built-upon area for all other residential and non-residential development in watershed outside of the critical area; Stormwater runoff from the development shall be transported by vegetated conveyances to the maximum extent practicable;

(B) High Density Option: If new development density exceeds the low density option requirements specified in Sub-Item (3)(b)(i)(A) of this Rule then development must control runoff from the first inch of rainfall; new residential and non-residential development shall not exceed 50 percent built-upon area;

(C) Land within the watershed shall be deemed compliant with the density requirements if the following condition is met: The density of all existing development at the time of reclassification does not exceed the density requirement when densities are averaged throughout the entire watershed area;

(D) Cluster development is allowed on a project-by-project basis as follows:

(I) overall density of the project meets associated density or stormwater control requirements of this Rule;

(II) buffers meet the minimum statewide water supply watershed protection requirements;

(III) built-upon areas are designed and located to minimize stormwater runoff impact to the receiving waters, minimize concentrated stormwater flow, maximize the use of sheet flow through vegetated areas; and maximize the flow length through vegetated areas;

(IV) areas of concentrated development are located in upland areas and away, to the maximum extent practicable, from surface waters and drainageways;

(V) remainder of tract to remain in vegetated or natural state;

(VI) area in the vegetated or natural state may be conveyed to a property owners association; a local government for preservation as a park or greenway; a conservation organization; or placed in a permanent conservation or farmland preservation easement;

(VII) a maintenance agreement for the vegetated or natural area shall be filed with the Register of Deeds; and

(VIII) cluster development that meets the applicable low density option requirements shall transport stormwater runoff from the development by vegetated conveyances to the maximum extent practicable;

(E) A maximum of 10 percent of each jurisdiction's portion of the watershed outside of the critical area as delineated on July 1, 1993 may be developed with new development projects and expansions of existing development of up to 70 percent built-upon surface area in addition to the new development approved in compliance with the appropriate requirements of Sub-Item (3)(b)(i)(A) or Sub-Item (3)(b)(i)(B) of this Rule. For expansions to existing development, the existing built-upon surface area is not counted toward the allowed 70 percent built-upon surface area. A local government having jurisdiction within the watershed may transfer, in whole or in part, its right to the 10 percent/70 percent land area to another local government within the watershed upon submittal of a joint resolution and review by the Commission. When the water supply watershed is composed of public lands, such as National Forest land, local governments may count the public land acreage within the watershed outside of the critical area in figuring the acreage allowed under this provision. For local governments that do not choose to use the high density option in that WS-III watershed, each project must, to the maximum extent practicable, minimize built-upon surface area, direct stormwater runoff away from surface waters, and incorporate best management practices to minimize water quality impacts; if the local government selects the high density development option within that WS-III watershed, then engineered stormwater controls must be employed for the new development;

(F) If local governments choose the high density development option which requires engineered stormwater controls, then they shall assume ultimate responsibility for operation and maintenance of the required controls as outlined in Rule .0104 of this Subchapter;

(G) Minimum 100 foot vegetative buffer is required for all new development activities that exceed the low density requirements as specified in Sub-Item (3)(b)(i)(A) and Sub-Item (3)(b)(ii)(A) of this Rule, otherwise a minimum 30 foot vegetative buffer for development is required along all perennial waters indicated on the most recent versions of U.S.G.S. 1:24,000 (7.5 minute) scale topographic maps or as determined by local government studies; nothing in this Rule shall stand as a bar to artificial streambank or shoreline stabilization;

(H) No new development is allowed in the buffer; water dependent structures, or other structures such as flag poles, signs and security lights, which result in only diminimus increases in impervious area and public projects such as road crossings and greenways may be allowed where no practicable alternative exists; these activities shall minimize built-upon surface area, direct runoff away from surface waters and maximize the utilization of BMPs;

(I) No NPDES permits shall be issued for landfills that discharge treated leachate;

(ii) Critical Area Nonpoint Source and Stormwater Pollution Control Criteria:

(A) Low Density Option: New development limited to either no more than one dwelling unit of single family detached residential development per acre (or 40,000 square foot lot excluding roadway right-of-way) or 12 percent built-upon area for all other residential and non-residential development; Stormwater runoff from the development shall be transported by vegetated conveyances to the maximum extent practicable;

(B) High Density Option: If new development exceeds the low density requirements specified in Sub-Item (3)(b)(ii)(A) of this Rule, then engineered stormwater controls must be used to control runoff from the first inch of rainfall; development shall not exceed 30 percent built-upon area;

(C) No new permitted sites for land application of residuals or petroleum contaminated soils are allowed;

(D) No new landfills are allowed;

(c) MBAS (Methylene-Blue Active Substances): not greater than 0.5 mg/l to protect the aesthetic qualities of water supplies and to prevent foaming;

(d) Odor producing substances contained in sewage, industrial wastes, or other wastes: only such amounts, whether alone or in combination with other substances or wastes, as shall not cause taste and odor difficulties in water supplies which cannot be corrected by treatment, impair the palatability of fish, or have a deleterious effect upon any best usage established for waters of this class;

(e) Chlorinated ~~Phenolic~~phenolic compounds: not greater than 1.0 ug/l ~~(phenols)~~ to protect water supplies from taste and odor problems from chlorinated phenols;

(f) Total hardness: not greater than 100 mg/l as calcium carbonate;

(g) Total dissolved solids: not greater than 500 mg/l;

(h) Toxic and other deleterious substances:

(i) Water quality standards (maximum permissible concentrations) to protect human health through water consumption and fish tissue consumption for non-carcinogens in Class WS-III waters:

(A) Barium: 1.0 mg/l;

(B) Chloride: 250 mg/l;

(C) Manganese: 200 ug/l;

(D) Nickel: 25 ug/l;

(E) Nitrate nitrogen: 10 mg/l;

(F) 2,4-D: 100 ug/l;

(G) 2,4,5-TP (Silvex): 10 ug/l;

(H) Sulfates: 250 mg/l;

(ii) Water quality standards (maximum permissible concentrations) to protect human health through water consumption and fish tissue consumption for carcinogens in Class WS-III waters:

(A) Aldrin: ~~0.127~~0.05 ng/l;

(B) Arsenic: 10 ug/l;

~~(C)~~Benzene: 1.19 ug/l;

~~(D)~~(C) ~~Beryllium: 7 ng/l;~~

~~(E)~~(D) Carbon tetrachloride: 0.254 ug/l;

~~(F)~~(E) Chlordane: ~~0.575~~0.8 ng/l;

~~(G)~~(F) Chlorinated benzenes: 488 ug/l;

~~(H)~~(G) DDT: ~~0.588~~0.2 ng/l;

~~(I)~~(H) Dieldrin: ~~0.135~~0.05 ng/l;

~~(J)~~(I) Dioxin: ~~0.000013~~0.000005 ng/l;

~~(K)~~(J) Heptachlor: ~~0.208~~0.08 ng/l;

~~(L)~~(K) Hexachlorobutadiene: ~~0.445~~0.44 ug/l;

~~(M)~~(L) Polynuclear aromatic ~~hydrocarbons:~~hydrocarbons (total of all PAHs): 2.8 ng/l;

~~(N)~~(M) Tetrachloroethane (1,1,2,2): ~~0.172~~0.17 ug/l;

~~(O)~~(N) Tetrachloroethylene: ~~0.8~~0.7 ug/l;

~~(P)~~<u>(O)</u> Trichloroethylene: ~~3.08~~<u>2.5</u> ug/l;

~~(Q)~~<u>(P)</u> Vinyl Chloride: ~~2~~<u>0.025</u> ug/l.

History Note: *Authority G.S. 143-214.1; 143-215.3(a)(1);*
Eff. September 9, 1979;
Amended Eff. <u>January1, 2007;</u> April 1, 2003; January 1, 1996; October 1, 1995; October 1, 1989.

15A NCAC 02B .0216 is proposed for amendment as follows:

15A NCAC 02B .0216 FRESH SURFACE WATER QUALITY STANDARDS FOR WS-IV WATERS

The following water quality standards apply to surface water supply waters that are classified WS-IV. Water quality standards applicable to Class C waters as described in Rule .0211 of this Section also apply to Class WS-IV waters.

(1) The best usage of WS-IV waters are as follows: a source of water supply for drinking, culinary, or food-processing purposes for those users where a more protective WS-I, WS-II or WS-III classification is not feasible and any other best usage specified for Class C waters.

(2) The conditions related to the best usage are as follows: waters of this class are protected as water supplies which are generally in moderately to highly developed watersheds or protected areas and meet average watershed development density levels as specified in Sub-Items (3)(b)(i)(A), (3)(b)(i)(B), (3)(b)(ii)(A) and (3)(b)(ii)(B) of this Rule. Discharges which qualify for a General Permit pursuant to 15A NCAC 02H .0127, trout farm discharges, recycle (closed loop) systems that only discharge in response to 10-year storm events, other stormwater discharges and domestic wastewater discharges shall be allowed in the protected and critical areas. Treated industrial wastewater discharges are allowed in the protected and critical areas; however, new industrial wastewater discharges in the critical area shall be required to meet the provisions of 15A NCAC 02B .0224(1)(b)(iv), (v) and (vii), and 15A NCAC 02B .0203. New industrial connections and expansions to existing municipal discharges with a pretreatment program pursuant to 15A NCAC 02H .0904 are allowed. The waters, following treatment required by the Division of Environmental Health, shall meet the Maximum Contaminant Level concentrations considered safe for drinking, culinary, or food-processing purposes which are specified in the national drinking water regulations and in the North Carolina Rules Governing Public Water Supplies, 15A NCAC 18C .1500. Sources of water pollution which preclude any of these uses on either a short-term or long-term basis shall be considered to be violating a water quality standard. The Class WS-II or WS-III classifications may be used to protect portions of Class WS-IV water supplies. For reclassifications of these portions of WS-IV water supplies occurring after the July 1, 1992 statewide reclassification, the more protective classification requested by local governments shall be considered by the Commission when all local governments having jurisdiction in the affected area(s) have adopted a resolution and the appropriate ordinances to protect the watershed or the Commission acts to protect a watershed when one or more local governments has failed to adopt necessary protection measures.

(3) Quality standards applicable to Class WS-IV Waters are as follows:

(a) Sewage, industrial wastes, non-process industrial wastes, or other wastes: none shall be allowed except for those specified in Item (2) of this Rule and Rule .0104 of this Subchapter and none shall be allowed which shall have an adverse effect on human health or which are not effectively treated to the satisfaction of the Commission and in accordance with the requirements of the Division of Environmental Health, North Carolina Department of

Environment and Natural Resources. Any discharges or industrial users subject to pretreatment standards may be required by the Commission to disclose all chemical constituents present or potentially present in their wastes and chemicals which could be spilled or be present in runoff from their facility which may have an adverse impact on downstream water supplies. These facilities may be required to have spill and treatment failure control plans as well as perform special monitoring for toxic substances;

(b) Nonpoint Source and Stormwater Pollution: none shall be allowed that would adversely impact the waters for use as water supply or any other designated use.

(i) Nonpoint Source and Stormwater Pollution Control Criteria For Entire Watershed or Protected Area:

(A) Low Density Option: Development activities which require a Sedimentation/Erosion Control Plan in accordance with 15A NCAC 4 established by the North Carolina Sedimentation Control Commission or approved local government programs as delegated by the Sedimentation Control Commission shall be limited to no more than either: two dwelling units of single family detached development per acre (or 20,000 square foot lot excluding roadway right-of-way) or 24 percent built-upon on area for all other residential and non-residential development; or three dwelling units per acre or 36 percent built-upon area for projects without curb and gutter street systems in the protected area outside of the critical area; Stormwater runoff from the development shall be transported by vegetated conveyances to the maximum extent practicable;

(B) High Density Option: If new development activities which require a Sedimentation/Erosion Control Plan exceed the low density requirements of Sub-Item (3)(b)(i)(A) of this Rule then development shall control the runoff from the first inch of rainfall; new residential and non-residential development shall not exceed 70 percent built-upon area;

(C) Land within the critical and protected area shall be deemed compliant with the density requirements if the following condition is met: The density of all existing development at the time of reclassification does not exceed the density requirement when densities are averaged throughout the entire area;

(D) Cluster development shall be allowed on a project-by-project basis as follows:

(I) overall density of the project meets associated density or stormwater control requirements of this Rule;

(II) buffers meet the minimum statewide water supply watershed protection requirements;

(III) built-upon areas are designed and located to minimize stormwater runoff impact to the receiving waters, minimize concentrated stormwater flow, maximize the use of sheet flow through vegetated areas, and maximize the flow length through vegetated areas;

(IV) areas of concentrated development are located in upland areas and away, to the maximum extent practicable, from surface waters and drainageways;

(V) remainder of tract to remain in vegetated or natural state;

(VI) area in the vegetated or natural state may be conveyed to a property owners association; a local government for preservation as a park or greenway; a conservation organization; or placed in a permanent conservation or farmland preservation easement;

(VII) a maintenance agreement for the vegetated or natural area shall be filed with the Register of Deeds, and;

(VIII) cluster development that meets the applicable low density option requirements shall transport stormwater runoff from the development by vegetated conveyances to the maximum extent practicable;

(E) If local governments choose the high density development option which requires engineered stormwater controls, then they shall assume ultimate responsibility for operation and maintenance of the required controls as outlined in Rule .0104 of this Subchapter;

(F) Minimum 100 foot vegetative buffer is required for all new development activities that exceed the low density option requirements as specified in Sub-Item (3)(b)(i)(A) or Sub-Item (3)(b)(ii)(A) of this Rule, otherwise a minimum 30 foot vegetative buffer for development shall be required along all perennial waters indicated on the most recent versions of U.S.G.S. 1:24,000 (7.5 minute) scale topographic maps or as determined by local government studies;

(G) No new development shall be allowed in the buffer; water dependent structures, or other structures, such as flag poles, signs and security lights, which result in only diminimus increases in impervious area and public projects such as road crossings and greenways may be allowed where no practicable alternative exists; these activities shall minimize built-upon surface area, divert runoff away from surface waters and maximize the utilization of BMPs;

(H) For local governments that do not use the high density option, a maximum of 10 percent of each jurisdiction's portion of the watershed outside of the critical area as delineated on July 1, 1995 may be developed with new development projects and expansions to existing development of up to 70 percent built-upon surface area in addition to the new development approved in compliance with the appropriate requirements of Sub-Item (3)(b)(i)(A) of this Rule. For expansions to existing development, the existing built-upon surface area shall not be counted toward the allowed 70 percent built-upon surface area. A local government having jurisdiction within the watershed may transfer, in whole or in part, its right to the 10 percent/70 percent land area to another local government within the watershed upon submittal of a joint resolution for review by the Commission. When the designated water supply watershed area is composed of public land, such as National Forest land, local governments may count the public land acreage within the designated watershed area outside of the critical area in figuring the acreage allowed under this provision. Each project shall, to the maximum extent practicable, minimize built-upon surface area, direct stormwater runoff away from surface waters and incorporate best management practices to minimize water quality impacts;

(ii) Critical Area Nonpoint Source and Stormwater Pollution Control Criteria:

(A) Low Density Option: New development activities which require a Sedimentation/Erosion Control Plan in accordance with 15A NCAC 4 established by the North Carolina Sedimentation Control Commission or approved local government programs as delegated by the Sedimentation Control Commission shall be limited to no more than two dwelling units of single family detached development per acre (or 20,000 square foot lot excluding roadway right-of-way) or 24 percent built-upon area for all other residential and non-residential development; Stormwater runoff from the development shall be transported by vegetated conveyances to the maximum extent practicable;

(B) High Density Option: If new development density exceeds the low density requirements specified in Sub-Item (3)(b)(ii)(A) of this Rule engineered stormwater controls shall be used to control runoff from the first inch of rainfall; new residential and non-residential development shall not exceed 50 percent built-upon area;

(C) No new permitted sites for land application of residuals or petroleum contaminated soils shall be allowed;

(D) No new landfills shall be allowed;

(c) MBAS (Methylene-Blue Active Substances): not greater than 0.5 mg/l to protect the aesthetic qualities of water supplies and to prevent foaming;

(d) Odor producing substances contained in sewage, industrial wastes, or other wastes: only such amounts, whether alone or in combination with other substances or waste, as will not cause taste and odor difficulties in water supplies which can not be corrected by treatment, impair the palatability of fish, or have a deleterious effect upon any best usage established for waters of this class;

(e) Chlorinated ~~Phenolic~~phenolic compounds: not greater than 1.0 ug/l ~~(phenols)~~ to protect water supplies from taste and odor problems due to chlorinated phenols shall be allowed. Specific phenolic compounds may be given a different limit if it is demonstrated not to cause taste and odor problems and not to be detrimental to other best usage;

(f) Total hardness shall not exceed 100 mg/l as calcium carbonate;

(g) Total dissolved solids shall not exceed 500 mg/l;

(h) Toxic and other deleterious substances:

(i) Water quality standards (maximum permissible concentrations) to protect human health through water consumption and fish tissue consumption for non-carcinogens in Class WS-IV waters shall be allowed as follows:

(A) Barium: 1.0 mg/l;

(B) Chloride: 250 mg/l;

(C) Manganese: 200 ug/l;

(D) Nickel: 25 ug/l;

(E) Nitrate nitrogen: 10.0 mg/l;

(F) 2,4-D: 100 ug/l;

(G) 2,4,5-TP (Silvex): 10 ug/l;

(H) Sulfates: 250 mg/l;

(ii) Water quality standards (maximum permissible concentrations) to protect human health through water consumption and fish tissue consumption for carcinogens in Class WS-IV waters shall be allowed as follows:

(A) Aldrin: ~~0.127~~0.05 ng/l;

(B) Arsenic: 10 ug/l;

(C) Benzene: 1.19 ug/l;

~~(D)Beryllium: 6.8 ng/l;~~

~~(E)~~(D) Carbon tetrachloride: 0.254 ug/l;

~~(F)~~(E) Chlordane: ~~0.575~~0.8 ng/l;

~~(G)~~(F) Chlorinated benzenes: 488 ug/l;

~~(H)~~(G) DDT: ~~0.588~~0.2 ng/l;

~~(I)~~(H) Dieldrin: ~~0.135~~0.05 ng/l;

~~(J)~~(I) Dioxin: ~~0.000013~~0.000005 ng/l;

~~(K)~~(J) Heptachlor: ~~0.208~~0.08 ng/l;

~~(L)~~(K) Hexachlorobutadiene: ~~0.445~~0.44 ug/l;

~~(M)~~(L) Polynuclear aromatic ~~hydrocarbons:~~hydrocarbons (total of all PAHs): 2.8 ng/l;

~~(N)~~(M) Tetrachloroethane (1,1,2,2): ~~0.172~~0.17 ug/l;

~~(O)~~(N) Tetrachloroethylene: ~~0.8~~0.7 ug/l;

~~(P)~~(O) Trichloroethylene: ~~3.08~~2.5 ug/l;

~~(Q)~~(P) Vinyl Chloride: ~~2~~0.025 ug/l.

History Note: *Authority G.S. 143-214.1; 143-215.3(a)(1);*
Eff. February 1, 1986;
Amended Eff. January 1, 2007; April 1, 2003; June 1, 1996; October 1, 1995; August 1, 1995; June 1, 1994.

15A NCAC 02B .0218 is proposed for amendment as follows:

15A NCAC 02B .0218 FRESH SURFACE WATER QUALITY STANDARDS FOR CLASS WS-V WATERS

The following water quality standards apply to surface water supply waters that are classified WS-V. Water quality standards applicable to Class C waters as described in Rule .0211 of this Section also apply to Class WS-V waters.

(1) The best usage of WS-V waters are as follows: waters that are protected as water supplies which are generally upstream and draining to Class WS-IV waters or waters previously used for drinking water supply purposes or waters used by industry to supply their employees, but not municipalities or counties, with a raw drinking water supply source, although this type of use is not restricted to WS-V classification. Class WS-V waters are suitable for all Class C uses. The Commission may consider a more protective classification for the water supply if a resolution requesting a more protective classification is submitted from all local governments having land use jurisdiction within the affected watershed; no categorical restrictions on watershed development or wastewater discharges are required, however, the Commission or its designee may apply appropriate management requirements as deemed necessary for the protection of waters downstream of receiving waters (15A NCAC 2B .0203).

(2) The conditions related to the best usage are as follows: waters of this class are protected water supplies; the waters, following treatment required by the Division of Environmental Health, shall meet the Maximum Contaminant Level concentrations considered safe for drinking, culinary, or food-processing purposes which are specified in the national drinking water regulations and in the North Carolina Rules Governing Public Water Supplies, 15A NCAC 18C .1500; sources of water pollution which preclude any of these uses on either a short-term or long-term basis shall be considered to be violating a water quality standard.

(3) Quality standards applicable to Class WS-V Waters are as follows:

(a) Sewage, industrial wastes, non-process industrial wastes, or other wastes: none which shall have an adverse effect on human health or which are not effectively treated to the satisfaction of the Commission and in accordance with the requirements of the Division of Environmental Health, North Carolina Department of Environment and Natural Resources; any discharges or industrial users subject to pretreatment standards may be required by the Commission to disclose all chemical constituents present or potentially present in their wastes and chemicals which could be spilled or be present in runoff from their facility which may have an adverse impact on downstream water supplies; these facilities may be required to have spill and treatment failure control plans as well as perform special monitoring for toxic substances;

(b) MBAS (Methylene-Blue Active Substances): not greater than 0.5 mg/l to protect the aesthetic qualities of water supplies and to prevent foaming;

(c) Nonpoint Source and Stormwater Pollution: none that would adversely impact the waters for use as water supply or any other designated use;

(d) Odor producing substances contained in sewage, industrial wastes, or other wastes: only such amounts, whether alone or in combination with other substances or waste, as will not cause taste and odor difficulties in water supplies which can not be corrected by treatment, impair the palatability of fish, or have a deleterious effect upon any best usage established for waters of this class;

(e) ~~Phenolic~~Chlorinated phenolic compounds: not greater than 1.0 ug/l ~~(phenols)~~ to protect water supplies from taste and odor problems due to chlorinated phenols; specific phenolic compounds may be given a different limit if it is demonstrated not to cause taste and odor problems and not to be detrimental to other best usage;

(f) Total hardness: not greater than 100 mg/l as calcium carbonate;

(g) Total dissolved solids: not greater than 500 mg/l;

(h) Toxic and other deleterious substances:

(i) Water quality standards (maximum permissible concentrations) to protect human health through water consumption and fish tissue consumption for non-carcinogens in Class WS-V waters:

(A) Barium: 1.0 mg/l;

(B) Chloride: 250 mg/l;

(C) Manganese: 200 ug/l;

(D) Nickel: 25 ug/l;

(E) Nitrate nitrogen: 10.0 mg/l;

(F) 2,4-D: 100 ug/l;

(G) 2,4,5-TP (Silvex): 10 ug/l;

(H) Sulfates: 250 mg/l.

(ii) Water quality standards (maximum permissible concentrations) to protect human health through water consumption and fish tissue consumption for carcinogens in Class WS-V waters:

(A) Aldrin: ~~0.127~~0.05 ng/l;

(B) Arsenic: 10 ug/l;

~~(C)~~Benzene: 1.19 ug/l;

~~(D)~~(C) ~~Beryllium: 6.8 ng/l;~~

~~(E)~~(D) Carbon tetrachloride: 0.254 ug/l;

~~(F)~~(E) Chlordane: ~~0.575~~0.8 ng/l;

~~(G)~~(F) Chlorinated benzenes: 488 ug/l;

~~(H)~~(G) DDT: ~~0.588~~0.2 ng/l;

~~(I)~~(H) Dieldrin: ~~0.135~~0.05 ng/l;

~~(J)~~(I) Dioxin: ~~0.000013~~0.000005 ng/l;

~~(K)~~(J) Heptachlor: ~~0.208~~0.08 ng/l;

~~(L)~~(K) Hexachlorobutadiene: ~~0.445~~0.44 ug/l;

~~(M)~~(L) Polynuclear aromatic ~~hydrocarbons:~~hydrocarbons (total of all PAHs): 2.8 ng/l;

~~(N)~~(M) Tetrachloroethane (1,1,2,2): ~~0.172~~0.17 ug/l;

~~(O)~~(N) Tetrachloroethylene: ~~0.8~~0.7 ug/l;

~~(P)~~(O) Trichloroethylene: ~~3.08~~2.5 ug/l;

~~(Q)~~(P) Vinyl Chloride: ~~2~~0.025 ug/l.

History Note: *Authority G.S. 143-214.1; 143-215.3(a)(1);*
Eff. October 1, 1989;
Amended Eff. January1, 2007; April 1, 2003; October 1, 1995.

15A NCAC 02B .0220 is proposed for amendment as follows:

15A NCAC 02B .0220 TIDAL SALT WATER QUALITY STANDARDS FOR CLASS SC WATERS

General. The water quality standards for all tidal salt waters are the basic standards applicable to Class SC waters. Additional and more stringent standards applicable to other specific tidal salt water classifications are specified in Rules .0221 and .0222 of this Section.

(1) Best Usage of Waters. Aquatic life propagation and maintenance of biological integrity (including fishing, fish and functioning PNAs), wildlife, secondary recreation, and any other usage except primary recreation or shellfishing for market purposes.

(2) Conditions Related to Best Usage. The waters shall be suitable for aquatic life propagation and maintenance of biological integrity, wildlife, and secondary recreation; Any source of water pollution which precludes any of these uses, including their functioning as PNAs, on either a short-term or a long-term basis shall be considered to be violating a water quality standard.

(3) Quality standards applicable to all tidal salt waters:

(a) Chlorophyll a (corrected): not greater than 40 ug/l in sounds, estuaries, and other waters subject to growths of macroscopic or microscopic vegetation; the Commission or its designee may prohibit or limit any discharge of waste into surface waters if, in the opinion of the Director, the surface waters experience or the discharge would result in growths of microscopic or macroscopic vegetation such that the standards established pursuant to this Rule would be violated or the intended best usage of the waters would be impaired;

(b) Dissolved oxygen: not less than 5.0 mg/l, except that swamp waters, poorly flushed tidally influenced streams or embayments, or estuarine bottom waters may have lower values if caused by natural conditions;

(c) Floating solids; settleable solids; sludge deposits: only such amounts attributable to sewage, industrial wastes or other wastes, as shall not make the waters unsafe or unsuitable for aquatic life and wildlife, or impair the waters for any designated uses;

(d) Gases, total dissolved: not greater than 110 percent of saturation;

(e) ~~Organisms of coliform group: fecal coliforms not to exceed geometric mean of 200/100 ml (MF count) based upon at least five consecutive samples examined during any 30 day period; not to exceed 400/100 ml in more than 20 percent of the samples examined during such period; violations of the fecal coliform standard are expected during rainfall events and, in some cases, this violation is expected to be caused by uncontrollable nonpoint source pollution; all coliform concentrations are to be analyzed using the MF technique unless high turbidity or other adverse conditions necessitate the tube dilution method; in case of controversy over results the MPN 5-tube dilution method shall be used as the reference method;~~Enterococcus, including *Enterococcus faecalis, Enterococcus faecium, Enterococcus avium* and *Enterococcus gallinarium*: not to exceed a geometric mean of 35 enterococci per

100 ml based upon a minimum of five samples within any consecutive 30 days. In accordance with 33 U.S.C. 1313 (Federal Water Pollution Control Act) for purposes of beach monitoring and notification, "Coastal Recreational Waters Monitoring, Evaluation and Notification" regulations (15A NCAC 18A .3400) are hereby incorporated by reference including any subsequent amendments;

(f) Oils; deleterious substances; colored or other wastes: only such amounts as shall not render the waters injurious to public health, secondary recreation or to aquatic life and wildlife or adversely affect the palatability of fish, aesthetic quality or impair the waters for any designated uses; for the purpose of implementing this Rule, oils, deleterious substances, colored or other wastes shall include but not be limited to substances that cause a film or sheen upon or discoloration of the surface of the water or adjoining shorelines pursuant to 40 CFR ~~110.4(a)-(b);~~110.3;

(g) pH: shall be normal for the waters in the area, which generally shall range between 6.8 and 8.5 except that swamp waters may have a pH as low as 4.3 if it is the result of natural conditions;

(h) Phenolic compounds: only such levels as shall not result in fish-flesh tainting or impairment of other best usage;

(i) Radioactive substances:

(i) Combined radium-226 and radium-228: The maximum average annual activity level (based on at least four samples, collected quarterly) for combined radium-226, and radium-228 shall not exceed five picoCuries per liter;

(ii) Alpha Emitters. The average annual gross alpha particle activity (including radium-226, but excluding radon and uranium) shall not exceed 15 picoCuries per liter;

(iii) Beta Emitters. The maximum average annual activity level (based on at least four samples, collected quarterly) for strontium-90 shall not exceed eight picoCuries per liter; nor shall the average annual gross beta particle activity (excluding potassium-40 and other naturally occurring radio-nuclides) exceed 50 picoCuries per liter; nor shall the maximum average annual activity level for tritium exceed 20,000 picoCuries per liter;

(j) Salinity: changes in salinity due to hydrological modifications shall not result in removal of the functions of a PNA; projects that are determined by the Director to result in modifications of salinity such that functions of a PNA are impaired will be required to employ water management practices to mitigate salinity impacts;

(k) Temperature: shall not be increased above the natural water temperature by more than 0.8 degrees C (1.44 degrees F) during the months of June, July, and August nor more than 2.2

degrees C (3.96 degrees F) during other months and in no cases to exceed 32 degrees C (89.6 degrees F) due to the discharge of heated liquids;

(l) Turbidity: the turbidity in the receiving water shall not exceed 25 NTU; if turbidity exceeds this level due to natural background conditions, the existing turbidity level shall not be increased. Compliance with this turbidity standard can be met when land management activities employ Best Management Practices (BMPs) [as defined by Rule ~~.0202(6)~~.0202 of this Section] recommended by the Designated Nonpoint Source Agency (as defined by Rule .0202 of this Section). BMPs must be in full compliance with all specifications governing the proper design, installation, operation and maintenance of such BMPs;

(m) Toxic substances: numerical water quality standards (maximum permissible levels) to protect aquatic life applicable to all tidal saltwaters:

(i) Arsenic, total recoverable: 50 ug/l;

(ii) Cadmium: 5.0 ug/l; attainment of these water quality standards in surface waters shall be based on measurement of total recoverable metals concentrations unless appropriate studies have been conducted to translate total recoverable metals to a toxic form. Studies used to determine the toxic form or translators must be designed according to the "Water Quality Standards Handbook Second Edition" published by the Environmental Protection Agency (EPA 823-B-94-005a) or "The Metals Translator: Guidance For Calculating a Total Recoverable Permit Limit From a Dissolved Criterion" published by the Environmental Protection Agency (EPA 823-B-96-007) which are hereby incorporated by reference including any subsequent amendments. The Director shall consider conformance to EPA guidance as well as the presence of environmental conditions that limit the applicability of translators in approving the use of metal translators.

(iii) Chromium, total: 20 ug/l;

(iv) Cyanide: 1.0 ug/l;

(v) Mercury: 0.025 ug/l;

(vi) Lead, total recoverable: 25 ug/l; collection of data on sources, transport and fate of lead shall be required as part of the toxicity reduction evaluation for dischargers that are out of compliance with whole effluent toxicity testing requirements and the concentration of lead in the effluent is concomitantly determined to exceed an instream level of 3.1 ug/l from the discharge;

(vii) Nickel: 8.3 ug/l; attainment of these water quality standards in surface waters shall be based on measurement of total recoverable metals concentrations unless appropriate studies have been conducted to translate total recoverable metals to a toxic form. Studies used to determine the toxic form or translators must be designed according to the "Water Quality Standards Handbook Second Edition" published by the Environmental Protection Agency (EPA 823-B-94-005a) or "The Metals Translator: Guidance For Calculating a Total Recoverable Permit Limit From a Dissolved Criterion" published by the Environmental Protection Agency (EPA 823-B-96-007) which are hereby incorporated by reference including any subsequent amendments. The Director shall consider conformance to EPA guidance as well as the presence of environmental conditions that limit the applicability of translators in approving the use of metal translators.

(viii) Pesticides:

(A) Aldrin: 0.003 ug/l;
(B) Chlordane: 0.004 ug/l;
(C) DDT: 0.001 ug/l;
(D) Demeton: 0.1 ug/l;
(E) Dieldrin: 0.002 ug/l;
(F) Endosulfan: 0.009 ug/l;
(G) Endrin: 0.002 ug/l;
(H) Guthion: 0.01 ug/l;
(I) Heptachlor: 0.004 ug/l;
(J) Lindane: 0.004 ug/l;
(K) Methoxychlor: 0.03 ug/l;
(L) Mirex: 0.001 ug/l;
(M) Parathion: 0.178 ug/l;
(N) Toxaphene: 0.0002 ug/l.

(ix) ~~Polycholorinated biphenyls:~~Polychlorinated biphenyls: (total of all PCBs and congeners identified) 0.001 ug/l;

(x) Selenium: 71 ug/l;

(xi) Trialkyltin compounds: ~~0.002~~0.007 ug/l expressed as tributyltin.

(4) Action Levels for Toxic Substances: if the Action Levels for any of the substances listed in this Subparagraph (which are generally not bioaccumulative and have variable toxicity to aquatic life because of chemical form, solubility, stream characteristics or associated waste characteristics) are determined by the waste load allocation to be exceeded in a receiving water by a discharge under the specified low flow criterion for toxic substances (Rule .0206 in this Section), the discharger shall be required to monitor the chemical or biological effects of the discharge; efforts shall be made by all dischargers to reduce or eliminate these substances from their effluents. Those substances for which Action Levels are listed in this Subparagraph may be limited as appropriate in the NPDES permit if sufficient information (to be determined for metals by measurements of that portion of the dissolved instream concentration of the Action Level parameter attributable to a specific NPDES permitted discharge) exists to indicate that any of those substances may be a causative factor resulting in toxicity

of the effluent. NPDES permit limits may be based on translation of the toxic form to total recoverable metals. Studies used to determine the toxic form or translators must be designed according to: "Water Quality Standards Handbook Second Edition" published by the Environmental Protection Agency (EPA 823-B-94-005a) or "The Metals Translator: Guidance For Calculating a Total Recoverable Permit Limit From a Dissolved Criterion" published by the Environmental Protection Agency (EPA 823-B-96-007) which are hereby incorporated by reference including any subsequent amendments. The Director shall consider conformance to EPA guidance as well as the presence of environmental conditions that limit the applicability of translators in approving the use of metal translators.

(a) Copper: 3 ug/l;

(b) Silver: 0.1 ug/l;

(c) Zinc: 86 ug/l.

History Note: *Authority G.S. 143-214.1; 143-215.3(a)(1);*
Eff. October 1, 1995;
Amended Eff. <u>January1, 2007;</u> August 1, 2000.

15A NCAC 02B .0221 is proposed for amendment as follows:

15A NCAC 02B .0221 TIDAL SALT WATER QUALITY STANDARDS FOR CLASS SA WATERS

The following water quality standards apply to surface waters that are used for shellfishing for market purposes and are classified SA. Water quality standards applicable to Class SC and SB waters as described in Rule .0220 and Rule .0222of this Section also apply to Class SA waters.

(1) Best Usage of Waters. Shellfishing for market purposes and any other usage specified by the "SB" or "SC" classification;

(2) Conditions Related to Best Usage. Waters shall meet the current sanitary and bacteriological standards as adopted by the Commission for Health Services and shall be suitable for shellfish culture; any source of water pollution which precludes any of these uses, including their functioning as PNAs, on either a short-term or a long-term basis shall be considered to be violating a water quality standard;

(3) Quality Standards applicable to Class SA Waters:

(a) Floating solids; settleable solids; sludge deposits: none attributable to sewage, industrial wastes or other wastes;

(b) Sewage: none;

(c) Industrial wastes, or other wastes: none which are not effectively treated to the satisfaction of the Commission in accordance with the requirements of the Division of ~~Health Services;~~Environmental Health;

(d) Organisms of coliform group: fecal coliform group not to exceed a median MF of 14/100 ml and not more than 10 percent of the samples shall exceed an MF count of 43/100 ml in those areas most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions.

History Note: *Authority G.S. 143-214.1; 143-215.3(a)(1);*
Eff. October 1, 1995.
Amended Eff. January 1, 2007.

Public Participation Process Record

Triennial Review
2004-2006

August 2005	Manufacturers and Chemical Industry Council (MCIC) – Brief Overview of Triennial Process – (Ms Coleen Sullins)	Raleigh, NC
August 2005	High Rock Lake/Falls Lake Technical Advisory Group (Included representatives from the Triangle J Council of Governments)	Raleigh, NC
August 2005	NC Conservation Network, Southern Environmental Law Center Environmental Defense League	Raleigh, NC
October 12, 2005	Water Quality Committee (WQC)- Information Item	Raleigh, NC
October 13, 2005	Pre-Treatment Consortium/LabNet– Joint meeting	Burlington, NC
October 19, 2005	Triangle J Council of Governments–Water Resources Advisory Council	RDU, NC
October 28, 2005	NC Center of Business and Industry (NCCBI)	Raleigh, NC
November 10, 2005	Professional Engineers of NC/ACEC Environment Committee	Raleigh, NC
December 2, 2006	Yadkin Pee-Dee River Basin Association	Mooresville, NC
January 11,2006	WQC/EMC – Request to Send Proposals to Environmental Management Commission for approval to go to Public Hearing	Raleigh, NC
January 24, 2006	Upper Cape Fear River Basin Assoc.; Technical Advisory Committee	Mebane, NC
March 9, 2006	EMC – Approval to proceed to public hearings with proposed Amendments	Raleigh, NC
May 23, 2006	Lab Technology Day	Raleigh, NC
July 24, 2006	Public Hearing	Mooresville NC
July 25, 2006	Public Hearing	Raleigh, NC
July 26, 2006	Public Hearing	Wilmington NC
September 1, 2006	Comment Period Ends	
October 26, 2006	League of Municipalities (Cadmium discussion only)	Raleigh, NC

Note from the Codifier: The notices published in this Section of the NC Register include the text of proposed rules. The agency must accept comments on the proposed rule(s) for at least 60 days from the publication date, or until the public hearing, or a later date if specified in the notice by the agency. If the agency adopts a rule that differs substantially from a prior published notice, the agency must publish the text of the proposed different rule and accept comment on the proposed different rule for 60 days.
Statutory reference: G.S. 150B-21.2.

TITLE 15A – DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

Notice is hereby given in accordance with G.S. 150B-21.2 that the Environmental Management Commission intends to amend the rules cited as 15A NCAC 02B .0204, .0208, .0211 - .0212, .0214 - .0216, .0218, .0220 - .0222.

Proposed Effective Date: *January 1, 2007*

Public Hearing:
Date: *Monday, July 24, 2006*
Time: *2:00 pm*
Location: *Mooresville Public Library, 304 South Main Street, Mooresville, NC 28115*

Public Hearing:
Date: *Tuesday, July 25, 2006*
Time: *2:00 pm*
Location: *Ground Floor Hearing Room, Archdale Building, 512 North Salisbury Street, Raleigh, NC*

Public Hearing:
Date: *Wednesday, July 26, 2006*
Time: *2:00 pm*
Location: *New Hanover County Public Library, Northeast Regional Branch, 1241 Military Cutoff Road, Wilmington, NC*

Reason for Proposed Action: *The Environmental Management Commission (EMC) has provided the Division of Water Quality with permission to conduct three public hearings to consider proposed permanent amendments to various rules that establish the surface water quality standards for North Carolina. These proposed amendments comprise the State's 2004 – 2006 Triennial Review of Surface Water Quality Standards, which is mandated by the Clean Water Act (CWA). If adopted, the proposals would implement the following changes to the surface water quality standards for North Carolina: 1) Replacement of the term "Dietary Intake" with the term "Relative Source Contribution." An assessment of total human exposure to a contaminant determines a Reference Dose; the Relative Source Contribution then apportions the Reference Dose among the media of concern. The use of Relative source Contribution provides the State with the ability to incorporate the latest scientific information by accounting for other sources of exposure, such as non-fish dietary intake and air, when deriving standards for non-carcinogens and non-linear carcinogens. 2) Updating the current fish consumption rate (FCR) to the national default fish consumption rate of 17.5 grams of fish/day. A default value of 17.5 grams/ person/ day is chosen to be protective of the majority of the general population. The US EPA values represent the uncooked weight intake of freshwater/ estuarine finfish and shellfish. 3) Base on revised US EPA methodology and research, new cancer potency factors are available for benzene and vinyl chloride. When implemented, the standard will lower the applicable acceptable human health protective concentrations. 4) Updated aquatic life protective concentrations for Cadmium and Tributyltin. As with the human health changes, the revised aquatic life criteria reflect the latest scientific knowledge regarding the effects of the pollutants on aquatic organisms. The revised criteria are average concentrations that can be present in a water body, but should not result in unacceptable effects on aquatic organisms and their uses. 5) Revisions to bacterial indicators in marine waters are mandated by the federal Beaches Environmental Assessment and Coastal Health Act (BEACH act) of 2000. The BEACH requires programs to monitor and analyze samples for microbiological indicators and to notify the public of the potential exposure to disease-causing microorganisms in coastal recreation waters. The BEACH Act also amended Section 303 of the CWA to require coastal states to adopt, in their water quality standards, EPA's published indicators for pathogens with criteria as protective as those published by EPA. The recommended bacterial indicator for coastal waters is proposed to change form fecal coliform to the EPA recommended indicator, enterococci. The Division must retain the use of a fecal coliform indicator for Class SA waters to accomplish the goals for the Food and Drug Administration criteria; therefore SA waters will have a dual indicator. 6) The public will have the opportunity to comment on three variances from surface water quality standards and the current thermal (temperature) variances. The three surface water standards consist of two variances from the chloride standard for Mt. Olive Pickle Company and Bay Valley Foods, LLC (formerly Dean Pickle and Specialty Products Company) (NC0001074 & NC 0001970) and a variance form the color standard for Blue Ridge Paper Products (NC0000272). Information concerning these water quality standards variances can be obtained by contacting the individual named in the comment procedures.*

Procedure by which a person can object to the agency on a proposed rule: *Written comments may be submitted to Connie Brower at DENR/ Division of Water Quality Planning Section, 1617 Mail Service Center, Raleigh, NC 27699-1617, or fax to (919) 715-5637, or email to Connie.Brower@ncmail.net, or by phone to Connie Brower at (919) 733-5083 extension 380.*

Comments may be submitted to: *Connie Brower, DENR/ Division of Water Quality Planning Section, 1617 Mail Service Center, Raleigh, NC 27699-1617, phone (919) 733-5083 extension 380, fax (919) 715-5637, email connie.brower@ncmail.net*

Comment period ends: *September 1, 2006*

Procedure for Subjecting a Proposed Rule to Legislative Review: If an objection is not resolved prior to the adoption of the rule, a person may also submit written objections to the Rules Review Commission. If the Rules Review Commission receives written and signed objections in accordance with G.S. 150B-21.3(b2) from 10 or more persons clearly requesting review by the legislature and the Rules Review Commission approves the rule, the rule will become effective as provided in G.S. 150B-21.3(b1). The Commission will receive written objections until 5:00 p.m. on the day following the day the Commission approves the rule. The Commission will receive those objections by mail, delivery service, hand delivery, or facsimile transmission. If you have any further questions concerning the submission of objections to the Commission, please call a Commission staff attorney at 919-733-2721.

Fiscal Impact: A copy of the fiscal note can be obtained from the agency.

☐ **State**
☒ **Local** *15A NCAC 02B .0220 - .0222*
☐ **Substantive** (≥$3,000,000)
☒ **None** *15A NCAC 02B .0204, .0208, .0211 - .0212, .0214 - .0216, .0218*

CHAPTER 02 - ENVIRONMENTAL MANAGEMENT

SUBCHAPTER 02B - SURFACE WATER AND WETLAND STANDARDS

SECTION .0200 - CLASSIFICATIONS AND WATER QUALITY STANDARDS APPLICABLE TO SURFACE WATERS AND WETLANDS OF NORTH CAROLINA

15A NCAC 02B .0204 LOCATION OF SAMPLING SITES AND MIXING ZONES

(a) Location of Sampling Sites. In conducting tests or making analytical determinations of classified waters to determine conformity or nonconformity with the established standards, samples shall be collected outside the limits of prescribed mixing zones. However, where appropriate, samples shall be collected within the mixing zone in order to ensure compliance with in-zone water quality requirements as outlined in Paragraph (b) of this Rule.

(b) Mixing Zones. A mixing zone may be established in the area of a discharge in order to provide reasonable opportunity for the mixture of the wastewater with the receiving waters. Water quality standards will not apply within regions defined as mixing zones, except that such zones will be subject to the conditions established in accordance with this Rule. The limits of such mixing zones will be defined by the division on a case-by-case basis after consideration of the magnitude and character of the waste discharge and the size and character of the receiving waters. Mixing zones will be determined such that discharges will not:

(1) result in acute toxicity to aquatic life [as defined by Rule .0202(1) of this Section] or prevent free passage of aquatic organisms around the mixing zone;
(2) result in offensive conditions;
(3) produce undesirable aquatic life or result in a dominance of nuisance species outside of the assigned mixing zone;
(4) endanger the public health or welfare.

In addition, a mixing zone will not be assigned for point source discharges of fecal coliform organisms in waters classified "WS-II," "WS-III," "B," ~~"SB,"~~ or "SA." Mixing zones will not be assigned for point source discharges of enterococci in waters classified "SB" or "SA." For the discharge of heated wastewater, compliance with federal rules and regulations pursuant to Section 316(a) of the Federal Water Pollution Control Act, as amended, shall constitute compliance with Subparagraph (b) of this Rule.

Authority G.S. 143-214.1.

15A NCAC 02B .0208 STANDARDS FOR TOXIC SUBSTANCES AND TEMPERATURE

(a) Toxic Substances. The concentration of toxic substances, either alone or in combination with other wastes, in surface waters shall not render waters injurious to aquatic life or wildlife, recreational activities, public health, or impair the waters for any designated uses. Specific standards for toxic substances to protect freshwater and tidal saltwater uses are listed in Rules .0211 and .0220 of this Section, respectively. Procedures for interpreting the narrative standard for toxic substances and numerical standards applicable to all waters are as follows:

(1) Aquatic life standards. The concentration of toxic substances shall not result in chronic toxicity. Any levels in excess of the chronic value will be considered to result in chronic toxicity. In the absence of direct measurements of chronic toxicity, the concentration of toxic substances shall not exceed the concentration specified by the fraction of the lowest LC50 value that predicts a no effect chronic level (as determined by the use of acceptable acute/chronic ratios). If an acceptable acute/chronic ratio is not available, then that toxic substance shall not exceed one-one hundredth (0.01) of the lowest LC50 or if it is affirmatively demonstrated that a toxic substance has a half-life of less than 96 hours the maximum concentration shall not exceed one-twentieth (0.05) of the lowest LC50.
(2) Human health standards. The concentration of toxic substances shall not exceed the level necessary to protect human health through exposure routes of fish (or shellfish) tissue consumption, water consumption, or other route identified as appropriate for the water body.
    (A) For non-carcinogens, these concentrations shall be determined using a Reference Dose (RfD) as

published by the U.S. Environmental Protection Agency pursuant to Section 304(a) of the Federal Water Pollution Control Act as amended or a RfD issued by the U.S. Environmental Protection Agency as listed in the Integrated Risk Information System (IRIS) file or a RfD approved by the Director after consultation with the State Health director. Water quality standards or criteria used to calculate water quality based effluent limitations to protect human health through the different exposure routes are determined as follows:

(i) Fish tissue consumption:

WQS = ~~(RfD-DT)~~(RfD x RSC) x Body Weight / (FCR x BCF)

where:

WQS = water quality standard or criteria;

RfD = reference dose;

~~DT = estimated non-fish dietary intake (when available);~~RSC = Relative Source Contribution

FCR = fish consumption rate ~~(assumed to be 6.5~~ (based upon 17.5 gm/person-day);

BCF = bioconcentration factor, or bioaccumulation factor (BAF), as appropriate.

BCF or BAF values are based on U.S. Environmental Protection Agency publications pursuant to Section 304(a) of the Federal Water Pollution Control Act as amended, literature values, or site specific bioconcentration data approved by the Commission or its designee; FCR values are average consumption rates for a 70 Kg adult for the lifetime of the population; alternative FCR values may be used when it is considered necessary to protect localized populations that may be consuming fish at a higher rate; RSC values , when made available through U.S. Environmental Protection Agency publications pursuant to Section 304(a) of the Federal Clean Water Pollution Control Act to account for non-water sources of exposure. May be either a percentage (multiplied) or amount subtracted, depending on whether multiple criteria are relevant to the chemical.

(ii) Water consumption (including a correction for fish consumption):

WQS = ~~(RfD-DT)~~(RfD x RSC) x Body Weight / [WCR+(FCRxBCF)]

where:

WQS = water quality standard or criteria;

RfD = reference dose;

~~DT = estimated non-fish dietary intake (when available);~~ RSC = Relative Source Contribution

FCR = fish consumption rate (~~assumed to be 6.5~~based upon 17.5 gm/person-day);

BCF = bioconcentration factor, or bioaccumulation factor (BAF), as appropriate;

WCR = water consumption rate (assumed to be two liters per day for adults).

To protect sensitive groups, exposure ~~may be~~is based on a 10 Kg child drinking one liter of water per day. Standards may also be based on drinking water standards based on the requirements of the Federal Safe Drinking Water Act [42 U.S.C. 300(f)(g)-1]. For non-carcinogens, specific numerical water quality standards have not been included in this Rule because water quality standards to protect aquatic life for all toxic substances for which standards have been considered are more stringent than numerical standards to protect human health from non-carcinogens through consumption of fish; standards to protect human health from non-carcinogens through water consumption are listed under the water supply classification standards in Rule .0211 of this Section; the equations listed in this Subparagraph shall be used to develop water quality based effluent limitations on a case-by-case basis for toxic substances that are not presently included in the water quality standards. Alternative FCR values may be used when it is considered necessary to protect localized populations that may be consuming fish at a higher rate;

(B) For carcinogens, the concentrations of toxic substances shall not result in unacceptable health risks and shall be based on a Carcinogenic Potency Factor (CPF). An unacceptable health risk for cancer shall be considered to be more than one case of cancer per one million people exposed (10-6 risk level). The CPF is a measure of the cancer-causing potency of a substance estimated by the upper 95 percent confidence limit of the slope of a straight line calculated by the Linearized

Multistage Model or other appropriate model according to U.S. Environmental Protection Agency Guidelines [FR 51 (185): 33992-34003; and FR 45 (231 Part V): 79318-79379]. Water quality standards or criteria for water quality based effluent limitations are calculated using the procedures given in Subparagraphs (A) and (B) of this Rule. Standards to protect human health from carcinogens through water consumption are listed under the water supply classification standards in Rules .0212, .0214, .0215, .0216, and .0218 of this Section; standards to protect human health from carcinogens through the consumption of fish (and shellfish) only are applicable to all waters as follows:

(i) Aldrin: ~~0.136~~0.05 ng/l;
(ii) Arsenic: 10 ug/l;
(iii) Benzene: ~~71.4~~51 ug/l;
(iv) Beryllium: ~~117~~50 ng/l;
(v) Carbon tetrachloride: ~~4.42~~1.6 ug/l;
(vi) Chlordane: ~~0.588~~0.8 ng/l;
(vii) DDT: ~~0.591~~0.2 ng/l;
(viii) Dieldrin: ~~0.144~~0.05 ng/l;
(ix) Dioxin: ~~0.000014~~0.000005 ng/l;
(x) Heptachlor: ~~0.214~~0.08 ng/l;
(xi) Hexachlorobutadiene: ~~49.7~~18 ug/l;
(xii) Polychlorinated ~~biphenyls:~~biphenyls (total of all identified PCBs and congeners): ~~0.079~~0.064 ng/l;
(xiii) Polynuclear aromatic ~~hydrocarbons:~~hydrocarbons (total of all PAHs): 31.1 ng/l;
(xiv) Tetrachloroethane (1,1,2,2): ~~10.8~~4 ug/l;
(xv) Tetrachloroethylene: 3.3 ug/L;
~~(xv)~~(xvi)Trichloroethylene: ~~92.4~~30 ug/l;
~~(xvi)~~(xvii)Vinyl chloride: ~~525~~2.4 ug/l.

The values listed in Subparts (i) through ~~(xvi)~~(xvii) in Part (B) of Subparagraph (2) of this Rule may be adjusted by the Commission or its designee on a case-by-case basis to account for site-specific or chemical-specific information pertaining to the assumed BCF, FCR or CPF values or other data.

(b) Temperature. The Commission may establish a water quality standard for temperature for specific water bodies other than the standards specified in Rules .0211 and .0220 of this Section, upon a case-by-case determination that thermal discharges to these waters, that serve or may serve as a source or receptor of industrial cooling water provide for the maintenance of the designated best use throughout a reasonable portion of the water body. Such revisions of the temperature standard must be consistent with the provisions of Section 316(a) of the Federal Water Pollution Control Act as ~~amended~~amended. ~~and shall be noted in Rule .0218 of this Section.~~ A listing of existing thermal revisions shall be maintained and made available to the public by the Division.

Authority G.S. 143-214.1; 143-215.3(a)(1).

15A NCAC 02B .0211 FRESH SURFACE WATER QUALITY STANDARDS FOR CLASS C WATERS

General. The water quality standards for all fresh surface waters are the basic standards applicable to Class C waters. See Rule .0208 of this Section for standards for toxic substances and temperature. Additional and more stringent standards applicable to other specific freshwater classifications are specified in Rules .0212, .0214, .0215, .0216, .0217, .0218, .0219, .0223, .0224 and .0225 of this Section.

(1) Best Usage of Waters. Aquatic life propagation and maintenance of biological integrity (including fishing, and fish), wildlife, secondary recreation, agriculture and any other usage except for primary recreation or as a source of water supply for drinking, culinary or food processing purposes;

(2) Conditions Related to Best Usage. The waters shall be suitable for aquatic life propagation and maintenance of biological integrity, wildlife, secondary recreation, and agriculture; sources of water pollution which preclude any of these uses on either a short-term or long-term basis shall be considered to be violating a water quality standard;

(3) Quality standards applicable to all fresh surface waters:

(a) Chlorophyll a (corrected): not greater than 40 ug/l for lakes, reservoirs, and other waters subject to growths of macroscopic or microscopic vegetation not designated as trout waters, and not greater than 15 ug/l for lakes, reservoirs, and other waters subject to growths of macroscopic or microscopic vegetation designated as trout waters (not applicable to lakes and reservoirs less than 10 acres in surface area); the Commission or its designee may prohibit or limit any discharge of waste into surface waters if, in the opinion of the Director, the surface waters experience or the discharge would result in growths of microscopic or macroscopic vegetation such that the standards established pursuant to this Rule would be violated or the intended best usage of the waters would be impaired;

(b) Dissolved oxygen: not less than 6.0 mg/l for trout waters; for non-trout waters, not less than a daily average of 5.0 mg/l with a minimum instantaneous value of not less than 4.0 mg/l; swamp waters, lake coves or backwaters, and lake bottom waters may have lower values if caused by natural conditions;

(c) Floating solids; settleable solids; sludge deposits: only such amounts attributable to sewage, industrial wastes or other wastes as shall not make the water unsafe or unsuitable for aquatic life and wildlife or impair the waters for any designated uses;

(d) Gases, total dissolved: not greater than 110 percent of saturation;

(e) Organisms of the coliform group: fecal coliforms shall not exceed a geometric mean of 200/100ml (MF count) based upon at least five consecutive samples examined during any 30 day period, nor exceed 400/100ml in more than 20 percent of the samples examined during such period; violations of the fecal coliform standard are expected during rainfall events and, in some cases, this violation is expected to be caused by uncontrollable nonpoint source pollution; all coliform concentrations are to be analyzed using the membrane filter technique unless high turbidity or other adverse conditions necessitate the tube dilution method; in case of controversy over results, the MPN 5-tube dilution technique shall be used as the reference method;

(f) Oils; deleterious substances; colored or other wastes: only such amounts as shall not render the waters injurious to public health, secondary recreation or to aquatic life and wildlife or adversely affect the palatability of fish, aesthetic quality or impair the waters for any designated uses; for the purpose of implementing this Rule, oils, deleterious substances, colored or other wastes shall include but not be limited to substances that cause a film or sheen upon or discoloration of the surface of the water or adjoining shorelines pursuant to 40 CFR ~~110.4(a)-(b)~~110.3(a)-(b) which are hereby incorporated by reference including any subsequent amendments and additions. This material is available for inspection at the Department of Environment and Natural Resources, Division of Water Quality, 512 North Salisbury Street, Raleigh, North Carolina. Copies may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402-9325 at a cost of ~~thirteen dollars ($13.00).~~forty-five dollars ($45.00).

(g) pH: shall be normal for the waters in the area, which generally shall range between 6.0 and 9.0 except that swamp waters may have a pH as low as 4.3 if it is the result of natural conditions;

(h) Phenolic compounds: only such levels as shall not result in fish-flesh tainting or impairment of other best usage;

(i) Radioactive substances:

(i) Combined radium-226 and radium-228: the maximum average annual activity level (based on at least four samples collected quarterly) for combined radium-226 and radium-228 shall not exceed five picoCuries per liter;

(ii) Alpha Emitters: the average annual gross alpha particle activity (including radium-226, but excluding radon and uranium) shall not exceed 15 picoCuries per liter;

(iii) Beta Emitters: the maximum average annual activity level (based on at least four samples, collected quarterly) for strontium-90 shall not exceed eight picoCuries per liter; nor shall the average annual gross beta particle activity (excluding potassium-40 and other naturally occurring radio-nuclides) exceed 50 picoCuries per liter; nor shall the maximum average annual activity level for tritium exceed 20,000 picoCuries per liter;

(j) Temperature: not to exceed 2.8 degrees C (5.04 degrees F) above the natural water temperature, and in no case to exceed 29 degrees C (84.2 degrees F) for mountain and upper piedmont waters and 32 degrees C (89.6 degrees F) for lower piedmont and coastal plain waters. The temperature for trout waters shall not be increased by more than 0.5 degrees C (0.9 degrees F) due to the discharge of heated liquids, but in no case to exceed 20 degrees C (68 degrees F);

(k) Turbidity: the turbidity in the receiving water shall not exceed 50 Nephelometric Turbidity Units (NTU) in streams not designated as trout waters and 10 NTU in streams, lakes or reservoirs designated as trout waters; for lakes and reservoirs not designated as trout waters, the turbidity shall not exceed 25 NTU; if turbidity exceeds these levels due to natural background conditions, the existing turbidity level cannot be increased. Compliance with this turbidity standard can be met when land management activities employ Best Management Practices (BMPs) [as defined by Rule .0202 of this Section] recommended by the Designated Nonpoint Source Agency [as defined by Rule .0202 of this Section]. BMPs must be in full compliance with all specifications governing the proper design, installation, operation and maintenance of such BMPs;

(l) Toxic substances: numerical water quality standards (maximum permissible levels) for the protection of human health applicable to all fresh surface waters are in Rule .0208 of this Section; numerical water quality standards (maximum permissible levels) to protect aquatic life applicable to all fresh surface waters:

(i) Arsenic: 50 ug/l;

(ii) Beryllium: 6.5 ug/l;

(iii) Cadmium: ~~0.4 ug/l for trout waters and 2.0 ug/l for non-trout waters;~~0.16 ug/L; attainment of these water quality standards in surface waters shall be based on measurement of total recoverable metals concentrations unless appropriate studies have been conducted to translate total recoverable metals to a toxic form. Studies used to determine the toxic form or translators must be designed according to the "Water Quality Standards Handbook Second Edition" published by the Environmental Protection Agency (EPA 823-B-94-005a) or "The Metals Translator: Guidance For Calculating a Total Recoverable Permit Limit From a Dissolved Criterion" published by the Environmental Protection Agency (EPA 823-B-96-007) which are hereby incorporated by reference including any subsequent amendments. The Director shall consider conformance to EPA guidance as well as the presence of environmental conditions that limit the applicability of translators in approving the use of metal translators.

(iv) Chlorine, total residual: 17 ug/l;

(v) Chromium, total recoverable: 50 ug/l;

(vi) Cyanide: 5.0 ug/l; unless site-specific criteria are developed based upon the aquatic life at the site utilizing The Recalculation Procedure in Appendix B of Appendix L in the Environmental Protection Agency's Water Quality Standards Handbook hereby incorporated by reference including any subsequent amendments;

(vii) Fluorides: 1.8 mg/l;

(viii) Lead, total recoverable: 25 ug/l; collection of data on sources, transport and fate of lead shall be required as part of the toxicity reduction evaluation for dischargers that are out of compliance with whole effluent toxicity testing requirements and the concentration of lead in the effluent is concomitantly determined to exceed an instream level of 3.1 ug/l from the discharge;

(ix) Mercury: 0.012 ug/l;

(x) Nickel: 88 ug/l; attainment of these water quality standards in surface waters shall be based on measurement of total recoverable metals concentrations unless appropriate studies have been conducted to translate total recoverable metals to a toxic form. Studies used to determine the toxic form or translators must be designed according to the "Water Quality Standards Handbook Second Edition" published by the Environmental Protection Agency (EPA 823-B-94-005a) or "The Metals Translator: Guidance For Calculating a Total Recoverable Permit Limit From a Dissolved Criterion" published by the Environmental Protection Agency (EPA 823-B-96-007) which are hereby incorporated by reference including any subsequent amendments. The Director shall consider conformance to EPA guidance as well as the presence of environmental conditions that limit the applicability of translators in approving the use of metal translators.

(xi) Pesticides:

(A) Aldrin: 0.002 ug/l;

(B) Chlordane: 0.004 ug/l;

(C) DDT: 0.001 ug/l;

(D) Demeton: 0.1 ug/l;

(E) Dieldrin: 0.002 ug/l;

(F) Endosulfan: 0.05 ug/l;

(G) Endrin: 0.002 ug/l;

(H) Guthion: 0.01 ug/l;

(I) Heptachlor: 0.004 ug/l;

(J) Lindane: 0.01 ug/l;

(K) Methoxychlor: 0.03 ug/l;

(L) Mirex: 0.001 ug/l;

(M) Parathion: 0.013 ug/l;

(N) Toxaphene: 0.0002 ug/l;

(xii) Polychlorinated ~~biphenyls:~~ <u>biphenyls: (total of all PCBs and congeners identified)</u> 0.001 ug/l;

(xiii) Selenium: 5 ug/l;

(xiv) Toluene: 11 ug/l or 0.36 ug/l in trout waters;

(xv) Trialkyltin compounds: ~~0.008~~ <u>0.07</u> ug/l expressed as tributyltin;

(4) Action Levels for Toxic Substances: if the Action Levels for any of the substances listed in this Subparagraph (which are generally not bioaccumulative and have variable toxicity to aquatic life because of chemical form, solubility, stream characteristics or associated waste characteristics) are determined by the waste load allocation to be exceeded in a receiving water by a discharge under the specified low flow criterion for toxic substances (Rule .0206 in this Section), the discharger shall monitor the chemical or biological effects of the discharge; efforts shall be made by all dischargers to reduce or eliminate these substances from their effluents. Those substances for which Action Levels are listed in this Subparagraph shall be limited as appropriate in the NPDES permit based on the Action Levels listed in this Subparagraph if sufficient information (to be determined for metals by measurements of that portion of the dissolved instream concentration of the Action Level parameter attributable to a specific NPDES permitted discharge) exists to indicate that any of those substances may be a causative factor resulting in toxicity of the effluent. NPDES permit limits may be based on translation of the toxic form to total recoverable metals. Studies used to determine the toxic form or translators must be designed according to "Water Quality Standards Handbook Second Edition" published by the Environmental Protection Agency (EPA 823-B-94-005a) or "The Metals Translator: Guidance For Calculating a Total Recoverable Permit Limit From a Dissolved Criterion" published by the Environmental Protection Agency (EPA 823-B-96-007) which are hereby incorporated by reference including any subsequent amendments. The Director shall consider conformance to EPA guidance as well as the presence of environmental conditions that limit the applicability of translators in approving the use of metal translators.

(a) Copper: 7 ug/l;

(b) Iron: 1.0 mg/l;
(c) Silver: 0.06 ug/l;
(d) Zinc: 50 ug/l;
(e) Chloride: 230 mg/l;

For purposes other than consideration of NPDES permitting of point source discharges as described in this Subparagraph, the Action Levels in this Rule, as measured by an appropriate analytical technique, per 15A NCAC 02B .0103(a), shall be considered as numerical ambient water quality standards.

Authority G.S. 143-214.1; 143-215.3(a)(1).

15A NCAC 02B .0212 FRESH SURFACE WATER QUALITY STANDARDS FOR CLASS WS-I WATERS

The following water quality standards apply to surface waters within water supply watersheds that are classified WS-I. Water quality standards applicable to Class C waters as described in Rule .0211 of this Section also apply to Class WS-I waters.

(1) The best usage of WS-I waters are as follows: a source of water supply for drinking, culinary, or food-processing purposes for those users desiring maximum protection of their water supplies, waters located on land in public ownership, and any best usage specified for Class C waters.

(2) The conditions related to the best usage are as follows: waters of this class are protected water supplies within essentially natural and undeveloped watersheds in public ownership with no permitted point source dischargers except those specified in Rule .0104 of this Subchapter; waters within this class must be relatively unimpacted by nonpoint sources of pollution; land use management programs are required to protect waters from nonpoint source pollution; the waters, following treatment required by the Division of Environmental Health, shall meet the Maximum Contaminant Level concentrations considered safe for drinking, culinary, and food-processing purposes which are specified in the national drinking water regulations and in the North Carolina Rules Governing Public Water Supplies, 15A NCAC 18C .1500; sources of water pollution which preclude any of these uses on either a short-term or long-term basis shall be considered to be violating a water quality standard. The Class WS-I classification may be used to protect portions of Class WS-II, WS-III and WS-IV water supplies. For reclassifications occurring after the July 1, 1992 statewide reclassification, the more protective classification requested by local governments shall be considered by the Commission when all local governments having jurisdiction in the affected area(s) have adopted a resolution and the appropriate ordinances to protect the watershed or the Commission acts to protect a watershed when one or more local governments has failed to adopt necessary protection measures.

(3) Quality standards applicable to Class WS-I Waters are as follows:

(a) MBAS (Methylene-Blue Active Substances): not greater than 0.5 mg/l to protect the aesthetic qualities of water supplies and to prevent foaming;
(b) Nonpoint Source Pollution: none that would adversely impact the waters for use as a water supply or any other designated use;
(c) Organisms of coliform group: total coliforms not to exceed 50/100 ml (MF count) as a monthly geometric mean value in watersheds serving as unfiltered water supplies;
(d) Chlorinated ~~Phenolic~~phenolic compounds: not greater than 1.0 ug/l ~~(phenols)~~ to protect water supplies from taste and odor problems from chlorinated phenols;
(e) Sewage, industrial wastes: none except those specified in Subparagraph (2) of this Paragraph or Rule .0104 of this Subchapter;
(f) Solids, total dissolved: not greater than 500 mg/l;
(g) Total hardness: not greater than 100 mg/l as calcium carbonate;
(h) Toxic and other deleterious substances:
(i) Water quality standards (maximum permissible concentrations) to protect human health through water consumption and fish tissue consumption for non-carcinogens in Class WS-I waters:
(A) Barium: 1.0 mg/l;
(B) Chloride: 250 mg/l;
(C) Manganese: 200 ug/l;
(D) Nickel: 25 ug/l;
(E) Nitrate nitrogen: 10.0 mg/l;
(F) 2,4-D: 100 ug/l;
(G) 2,4,5-TP (Silvex): 10 ug/l;
(H) Sulfates: 250 mg/l;
(ii) Water quality standards (maximum permissible concentrations) to protect human health through water consumption and fish tissue consumption for carcinogens in Class WS-I waters:

(A) Aldrin: ~~0.127~~0.05 ng/l;
(B) Arsenic: 10 ug/l;
(C) Benzene: 1.19 ug/l;
(D) Beryllium: ~~6.8~~7 ng/l;
(E) Carbon tetrachloride: 0.254 ug/l;
(F) Chlordane: ~~0.575~~0.8 ng/l;
(G) Chlorinated benzenes: 488 ug/l;
(H) DDT: ~~0.588~~0.2 ng/l;
(I) Dieldrin: ~~0.135~~0.05 ng/l;
(J) Dioxin: ~~0.000013~~0.000005 ng/l;
(K) Heptachlor: ~~0.208~~0.08 ng/l;
(L) Hexachlorobutadiene: ~~0.445~~0.44 ug/l;
(M) Polynuclear aromatic ~~hydrocarbons:~~hydrocarbons (total of all PAHs): 2.8 ng/l;
(N) Tetrachloroethane (1,1,2,2): ~~0.172~~0.17 ug/l;
(O) Tetrachloroethylene: ~~0.8~~0.7 ug/l;
(P) Trichloroethylene: ~~3.08~~2.5 ug/l;
(Q) Vinyl Chloride: ~~2~~0.025 ug/l.

Authority G.S. 143-214.1; 143-215.3(a)(1).

15A NCAC 02B .0214 FRESH SURFACE WATER QUALITY STANDARDS FOR CLASS WS-II WATERS

The following water quality standards apply to surface waters within water supply watersheds that are classified WS-II. Water quality standards applicable to Class C waters as described in Rule .0211 of this Section also apply to Class WS-II waters.

(1) The best usage of WS-II waters are as follows: a source of water supply for drinking, culinary, or food-processing purposes for those users desiring maximum protection for their water supplies where a WS-I classification is not feasible and any best usage specified for Class C waters.

(2) The conditions related to the best usage are as follows: waters of this class are protected as water supplies which are in predominantly undeveloped watersheds and meet average watershed development density levels as specified in Sub-Items (3)(b)(i)(A), (3)(b)(i)(B), (3)(b)(ii)(A) and (3)(b)(ii)(B) of this Rule; discharges which qualify for a General Permit pursuant to 15A NCAC 2H .0127, trout farm discharges, recycle (closed loop) systems that only discharge in response to 10-year storm events and other stormwater discharges are allowed in the entire watershed; new domestic and industrial discharges of treated wastewater are not allowed in the entire watershed; the waters, following treatment required by the Division of Environmental Health, shall meet the Maximum Contaminant Level concentrations considered safe for drinking, culinary, and food-processing purposes which are specified in the national drinking water regulations and in the North Carolina Rules Governing Public Water Supplies, 15A NCAC 18C .1500; sources of water pollution which preclude any of these uses on either a short-term or long-term basis shall be considered to be violating a water quality standard. The Class WS-II classification may be used to protect portions of Class WS-III and WS-IV water supplies. For reclassifications of these portions of Class WS-III and WS-IV water supplies occurring after the July 1, 1992 statewide reclassification, the more protective classification requested by local governments shall be considered by the Commission when all local governments having jurisdiction in the affected area(s) have adopted a resolution and the appropriate ordinances to protect the watershed or the Commission acts to protect a watershed when one or more local governments has failed to adopt necessary protection measures.

(3) Quality standards applicable to Class WS-II Waters are as follows:

(a) Sewage, industrial wastes, non-process industrial wastes, or other wastes: none except for those specified in either Item (2) of this Rule and Rule .0104 of this Subchapter; and none which shall have an adverse effect on human health or which are not effectively treated to the satisfaction of the Commission and in accordance with the requirements of the Division of Environmental Health, North Carolina Department of Environment and Natural Resources; any discharger may be required upon request by the Commission to disclose all chemical constituents present or potentially present in their wastes and chemicals which could be spilled or be present in runoff from their facility which may have an adverse impact on downstream water quality; these facilities may be required to have spill and treatment failure control plans as well as perform special monitoring for toxic substances;

(b) Nonpoint Source and Stormwater Pollution: none that would adversely impact the waters for use as a water supply or any other designated use;

(i) Nonpoint Source and Stormwater Pollution Control Criteria For Entire Watershed:

(A) Low Density Option: Development density must be limited to either no more than one dwelling unit per acre of single family detached residential development (or 40,000 square foot lot excluding roadway right-of-way) or 12 percent built-upon area for all other residential and non-residential development in the watershed outside of the critical area; Stormwater runoff from the development shall be transported by vegetated conveyances to the maximum extent practicable;

(B) High Density Option: If new development exceeds the low density option requirements as stated in Sub-Item (3)(b)(i)(A) of this Rule, then engineered stormwater controls must be used to control runoff from the first inch of rainfall; new residential and non-residential development shall not exceed 30 percent built-upon area;

(C) Land within the watershed shall be deemed compliant with the density requirements if the following condition is met: The density of all existing development at the time of reclassification does not exceed the density requirement when densities are averaged throughout the entire watershed area at the time of classification;

(D) Cluster development is allowed on a project-by-project basis as follows:

(I) overall density of the project meets associated density or stormwater control requirements of this Rule;

(II) buffers meet the minimum statewide water supply watershed protection requirements;

(III) built-upon areas are designed and located to minimize stormwater runoff impact to the receiving waters, minimize concentrated stormwater flow, maximize the use of sheet flow through vegetated areas; and maximize the flow length through vegetated areas;

(IV) areas of concentrated development are located in upland areas and away, to the maximum extent practicable, from surface waters and drainageways;

(V) remainder of tract to remain in vegetated or natural state;

(VI) area in the vegetated or natural state may be conveyed to a property owners association; a local government for preservation as a park or greenway; a conservation organization; or placed in a permanent conservation or farmland preservation easement;

(VII) a maintenance agreement for the vegetated or natural area shall be filed with the Register of Deeds; and

(VIII) cluster development that meets the applicable low density option requirements shall transport stormwater runoff from the development by vegetated conveyances to the maximum extent practicable;

(E) A maximum of 10 percent of each jurisdiction's portion of the watershed outside of the critical area as delineated on July 1, 1993 may be developed with new development projects and expansions of existing development of up to 70 percent built-upon surface area in addition to the new development approved in compliance with the appropriate requirements of Sub-Item (3)(b)(i)(A) or Sub-Item (3)(b)(i)(B) of this Rule. For expansions to existing development, the existing built-upon surface area is not counted toward the allowed 70 percent built-upon surface area. A local government having jurisdiction within the watershed may transfer, in whole or in part, its right to the 10 percent/70 percent land area to another local government within the watershed upon submittal of a joint resolution and review by the Commission. When the water supply watershed is composed of public lands, such as National Forest land, local governments may count the public land acreage within the watershed outside of the critical area in calculating the acreage allowed under this provision. For local governments that do not choose to use the high density option in that WS-II watershed, each project must, to the maximum extent practicable, minimize built-upon surface area, direct stormwater runoff away from surface waters and incorporate best management practices to minimize water quality impacts; if the local government selects the high density development option within that WS-II watershed, then engineered stormwater controls must be employed for the new development;

(F) If local governments choose the high density development option which requires stormwater controls, then they shall assume ultimate responsibility for operation and maintenance of the required controls as outlined in Rule .0104 of this Subchapter;

(G) Minimum 100 foot vegetative buffer is required for all new development activities that exceed the low density option requirements as specified in Sub-Items (3)(b)(i)(A) and Sub-Item (3)(b)(ii)(A) of this Rule; otherwise a minimum 30 foot vegetative buffer for development activities is required along all perennial waters indicated on the most recent versions of U.S.G.S. 1:24,000 (7.5 minute) scale topographic maps or as determined by local government studies; nothing in this Rule shall stand as a bar to artificial streambank or shoreline stabilization;

(H) No new development is allowed in the buffer; water dependent structures, or other structures such as flag poles, signs and security lights, which result in only diminimus increases in impervious area and public projects such as road crossings and greenways may be allowed where no practicable alternative exists; these activities shall minimize built-upon surface area, direct runoff away from the surface waters and maximize the utilization of BMPs;

(I) No NPDES permits shall be issued for landfills that discharge treated leachate;

(ii) Critical Area Nonpoint Source and Stormwater Pollution Control Criteria:

(A) Low Density Option: New development is limited to either no more than one dwelling unit of single family detached residential development per two acres (or 80,000 square foot lot excluding roadway right-of-way) or six percent built-upon area for all other residential and non-residential development; Stormwater runoff from the development shall be transported by vegetated conveyances to the maximum extent practicable;

(B) High Density Option: If new development density exceeds the low density requirements specified in Sub-Item

(3)(b)(ii)(A) of this Rule, then engineered stormwater controls must be used to control runoff from the first inch of rainfall; new residential and non-residential development density not to exceed 24 percent built-upon area;

(C) No new permitted sites for land application of residuals or petroleum contaminated soils are allowed;

(D) No new landfills are allowed;

(c) MBAS (Methylene-Blue Active Substances): not greater than 0.5 mg/l to protect the aesthetic qualities of water supplies and to prevent foaming;

(d) Odor producing substances contained in sewage or other wastes: only such amounts, whether alone or in combination with other substances or wastes, as will not cause taste and odor difficulties in water supplies which cannot be corrected by treatment, impair the palatability of fish, or have a deleterious effect upon any best usage established for waters of this class;

(e) Chlorinated ~~Phenolic~~phenolic compounds: not greater than 1.0 ug/l ~~(phenols)~~ to protect water supplies from taste and odor problems from chlorinated phenols;

(f) Total hardness: not greater than 100 mg/l as calcium carbonate;

(g) Total dissolved solids: not greater than 500 mg/l;

(h) Toxic and other deleterious substances:

(i) Water quality standards (maximum permissible concentrations) to protect human health through water consumption and fish tissue consumption for non-carcinogens in Class WS-II waters:

(A) Barium: 1.0 mg/l;

(B) Chloride: 250 mg/l;

(C) Manganese: 200 ug/l;

(D) Nickel: 25 ug/l;

(E) Nitrate nitrogen: 10 mg/l;

(F) 2,4-D: 100 ug/l;

(G) 2,4,5-~~TP~~: TP (Silvex): 10 ug/l;

(H) Sulfates: 250 mg/l;

(ii) Water quality standards (maximum permissible concentrations) to protect human health through water consumption and fish tissue consumption for carcinogens in Class WS-II waters:

(A) Aldrin: ~~0.127~~ 0.05 ng/l;

(B) Arsenic: 10 ug/l;

(C) Benzene: 1.19 ug/l;

(D) Beryllium: ~~6.8~~ 7 ng/l;

(E) Carbon tetrachloride: 0.254 ug/l;

(F) Chlordane: ~~0.575~~ 0.8 ng/l;

(G) Chlorinated benzenes: 488 ug/l;

(H) DDT: ~~0.588~~ 0.2 ng/l;

(I) Dieldrin: ~~0.1350~~ 0.05 ng/l;

(J) Dioxin: ~~0.000013~~ 0.000005 ng/l;

(K) Heptachlor: ~~0.208~~ 0.08 ng/l;

(L) Hexachlorobutadiene: ~~0.445~~ 0.44 ug/l;

(M) Polynuclear aromatic ~~hydrocarbons:~~hydrocarbons (total of all PAHs): 2.8 ng/l;

(N) Tetrachloroethane (1,1,2,2): ~~0.172~~ 0.17 ug/l;

(O) Tetrachloroethylene: ~~0.8~~ 0.7 ug/l;

(P) Trichloroethylene: ~~3.08~~ 2.5 ug/l;

(Q) Vinyl Chloride: ~~2~~ 0.025 ug/l.

Authority G.S. 143-214.1; 143-215.3(a)(1).

15A NCAC 02B .0215 FRESH SURFACE WATER QUALITY STANDARDS FOR CLASS WS-III WATERS

The following water quality standards apply to surface water supply waters that are classified WS-III. Water quality standards applicable to Class C waters as described in Rule .0211 of this Section also apply to Class WS-III waters.

(1) The best usage of WS-III waters are as follows: a source of water supply for drinking, culinary, or food-processing purposes for those users where a more protective WS-I or WS-II classification is not feasible and any other best usage specified for Class C waters.

(2) The conditions related to the best usage are as follows: waters of this class are protected as water supplies which are generally in low to moderately developed watersheds and meet average watershed development density levels as specified in Sub-Items (3)(b)(i)(A), (3)(b)(i)(B), (3)(b)(ii)(A) and (3)(b)(ii)(B) of this Rule; discharges that qualify for a General Permit pursuant to 15A NCAC 2H .0127, trout farm discharges, recycle (closed loop) systems that only discharge in response to 10-year storm events, and other stormwater discharges are allowed in the entire watershed; treated domestic wastewater discharges are allowed in the entire watershed but no new domestic wastewater discharges are allowed in the critical area; no new industrial wastewater discharges except non-process industrial discharges are allowed in the entire watershed; the waters, following treatment required by the Division of Environmental Health, shall meet the Maximum Contaminant Level concentrations considered safe for drinking, culinary, or food-processing purposes which are specified in the national drinking water regulations and in the North Carolina Rules Governing Public Water Supplies, 15A NCAC 18C .1500; sources of water pollution which preclude any of these uses on either a short-term or long-term basis shall be considered to be violating a water quality standard; the Class WS-III classification may be used to protect portions of Class WS-IV water supplies. For reclassifications of these portions of WS-IV water supplies occurring after the July 1, 1992 statewide reclassification, the more protective classification requested by local governments shall be considered by the Commission when all local governments having jurisdiction in the affected area(s) have adopted a resolution and the appropriate ordinances to protect the watershed or the Commission acts to protect a watershed when one or more local governments has failed to adopt necessary protection measures.

(3) Quality standards applicable to Class WS-III Waters are as follows:

(a) Sewage, industrial wastes, non-process industrial wastes, or other wastes: none except for those specified in Item (2) of this Rule and Rule .0104 of this Subchapter; and none which shall have an adverse effect on human health or which are not effectively treated to the satisfaction of the Commission and in accordance with the requirements of the Division of Environmental Health, North Carolina Department of Environment and Natural Resources; any discharger may be required by the Commission to disclose all chemical constituents present or potentially present in their wastes and chemicals which could be spilled or be present in runoff from their facility which may have an adverse impact on downstream water quality; these facilities may be required to have spill and treatment failure control plans as well as perform special monitoring for toxic substances;

(b) Nonpoint Source and Stormwater Pollution: none that would adversely impact the waters for use as water supply or any other designated use;

(i) Nonpoint Source and Stormwater Pollution Control Criteria For Entire Watershed:

(A) Low Density Option: Development density must be limited to either no more than two dwelling units of single family detached residential development per acre (or 20,000 square foot lot excluding roadway right-of-way) or 24 percent built-upon area for all other residential and non-residential development in watershed outside of the critical area; Stormwater runoff from the development shall be transported by vegetated conveyances to the maximum extent practicable;

(B) High Density Option: If new development density exceeds the low density option requirements specified in Sub-Item (3)(b)(i)(A) of this Rule then development must control runoff from the first inch of rainfall; new residential and non-residential development shall not exceed 50 percent built-upon area;

(C) Land within the watershed shall be deemed compliant with the density requirements if the following condition is met: The density of all existing development at the time of reclassification does not exceed the density requirement when densities are averaged throughout the entire watershed area;

(D) Cluster development is allowed on a project-by-project basis as follows:

(I) overall density of the project meets associated density or stormwater control requirements of this Rule;

(II) buffers meet the minimum statewide water supply watershed protection requirements;

(III) built-upon areas are designed and located to minimize stormwater runoff impact to the receiving waters, minimize concentrated stormwater flow, maximize the use of sheet flow through vegetated areas; and maximize the flow length through vegetated areas;

(IV) areas of concentrated development are located in upland areas and away, to the maximum extent practicable, from surface waters and drainageways;

(V) remainder of tract to remain in vegetated or natural state;

(VI) area in the vegetated or natural state may be conveyed to a property owners association; a local government for preservation as a park or greenway; a conservation organization; or placed in a permanent conservation or farmland preservation easement;

(VII) a maintenance agreement for the vegetated or natural area shall be filed with the Register of Deeds; and

(VIII) cluster development that meets the applicable low density option requirements shall transport stormwater runoff from the development by vegetated conveyances to the maximum extent practicable;

(E) A maximum of 10 percent of each jurisdiction's portion of the watershed outside of the critical area as delineated on July 1, 1993 may be developed with new development projects and expansions of existing development of up to 70 percent built-upon surface area in addition to the new development approved in compliance with the appropriate requirements of Sub-Item (3)(b)(i)(A) or

Sub-Item (3)(b)(i)(B) of this Rule. For expansions to existing development, the existing built-upon surface area is not counted toward the allowed 70 percent built-upon surface area. A local government having jurisdiction within the watershed may transfer, in whole or in part, its right to the 10 percent/70 percent land area to another local government within the watershed upon submittal of a joint resolution and review by the Commission. When the water supply watershed is composed of public lands, such as National Forest land, local governments may count the public land acreage within the watershed outside of the critical area in figuring the acreage allowed under this provision. For local governments that do not choose to use the high density option in that WS-III watershed, each project must, to the maximum extent practicable, minimize built-upon surface area, direct stormwater runoff away from surface waters, and incorporate best management practices to minimize water quality impacts; if the local government selects the high density development option within that WS-III watershed, then engineered stormwater controls must be employed for the new development;

(F) If local governments choose the high density development option which requires engineered stormwater controls, then they shall assume ultimate responsibility for operation and maintenance of the required controls as outlined in Rule .0104 of this Subchapter;

(G) Minimum 100 foot vegetative buffer is required for all new development activities that exceed the low density requirements as specified in Sub-Item (3)(b)(i)(A) and Sub-Item (3)(b)(ii)(A) of this Rule, otherwise a minimum 30 foot vegetative buffer for development is required along all perennial waters indicated on the most recent versions of U.S.G.S. 1:24,000 (7.5 minute) scale topographic maps or as determined by local government studies; nothing in this Rule shall stand as a bar to artificial streambank or shoreline stabilization;

(H) No new development is allowed in the buffer; water dependent structures, or other structures such as flag poles, signs and security lights, which result in only diminimus increases in impervious area and public projects such as road crossings and greenways may be allowed where no practicable alternative exists; these activities shall minimize built-upon surface area, direct runoff away from surface waters and maximize the utilization of BMPs;

(I) No NPDES permits shall be issued for landfills that discharge treated leachate;

(ii) Critical Area Nonpoint Source and Stormwater Pollution Control Criteria:

(A) Low Density Option: New development limited to either no more than one dwelling unit of single family detached residential development per acre (or 40,000 square foot lot excluding roadway right-of-way) or 12 percent built-upon area for all other residential and non-residential development; Stormwater runoff from the development shall be transported by vegetated conveyances to the maximum extent practicable;

(B) High Density Option: If new development exceeds the low density requirements specified in Sub-Item (3)(b)(ii)(A) of this Rule, then engineered stormwater controls must be used to control runoff from the first inch of rainfall; development shall not exceed 30 percent built-upon area;

(C) No new permitted sites for land application of residuals or petroleum contaminated soils are allowed;

(D) No new landfills are allowed;

(c) MBAS (Methylene-Blue Active Substances): not greater than 0.5 mg/l to protect the aesthetic qualities of water supplies and to prevent foaming;

(d) Odor producing substances contained in sewage, industrial wastes, or other wastes: only such amounts, whether alone or in combination with other substances or wastes, as shall not cause taste and odor difficulties in water supplies which cannot be corrected by treatment, impair the palatability of fish, or have a deleterious effect upon any best usage established for waters of this class;

(e) Chlorinated ~~Phenolic~~phenolic compounds: not greater than 1.0 ug/l ~~(phenols)~~ to protect water supplies from taste and odor problems from chlorinated phenols;

(f) Total hardness: not greater than 100 mg/l as calcium carbonate;

(g) Total dissolved solids: not greater than 500 mg/l;

(h) Toxic and other deleterious substances:

(i) Water quality standards (maximum permissible concentrations) to protect human health through water consumption and fish tissue consumption for non-carcinogens in Class WS-III waters:

(A) Barium: 1.0 mg/l;

(B) Chloride: 250 mg/l;

(C) Manganese: 200 ug/l;

(D) Nickel: 25 ug/l;

(E) Nitrate nitrogen: 10 mg/l;

(F) 2,4-D: 100 ug/l;

(G) 2,4,5-TP (Silvex): 10 ug/l;

(H) Sulfates: 250 mg/l;

(ii) Water quality standards (maximum permissible concentrations) to protect human health through water consumption and fish tissue consumption for carcinogens in Class WS-III waters:

(A) Aldrin: ~~0.127~~0.05 ng/l;

(B) Arsenic: 10 ug/l;

(C) Benzene: 1.19 ug/l;

(D) Beryllium: ~~6.8~~7 ng/l;

(E) Carbon tetrachloride: 0.254 ug/l;

(F) Chlordane: ~~0.575~~0.8 ng/l;

(G) Chlorinated benzenes: 488 ug/l;

(H) DDT: ~~0.588~~0.2 ng/l;

(I) Dieldrin: ~~0.135~~0.05 ng/l;

(J) Dioxin: ~~0.000013~~0.000005 ng/l;

(K) Heptachlor: ~~0.208~~0.08 ng/l;

(L) Hexachlorobutadiene: ~~0.445~~0.44 ug/l;

(M) Polynuclear aromatic ~~hydrocarbons:~~hydrocarbons (total of all PAHs): 2.8 ng/l;

(N) Tetrachloroethane (1,1,2,2): ~~0.172~~0.17 ug/l;

(O) Tetrachloroethylene: ~~0.8~~0.7 ug/l;

(P) Trichloroethylene: ~~3.08~~2.5 ug/l;

(Q) Vinyl Chloride: ~~2~~0.025 ug/l.

Authority G.S. 143-214.1; 143-215.3(a)(1).

15A NCAC 02B .0216 FRESH SURFACE WATER QUALITY STANDARDS FOR WS-IV WATERS

The following water quality standards apply to surface water supply waters that are classified WS-IV. Water quality standards applicable to Class C waters as described in Rule .0211 of this Section also apply to Class WS-IV waters.

(1) The best usage of WS-IV waters are as follows: a source of water supply for drinking, culinary, or food-processing purposes for those users where a more protective WS-I, WS-II or

WS-III classification is not feasible and any other best usage specified for Class C waters.

(2) The conditions related to the best usage are as follows: waters of this class are protected as water supplies which are generally in moderately to highly developed watersheds or protected areas and meet average watershed development density levels as specified in Sub-Items (3)(b)(i)(A), (3)(b)(i)(B), (3)(b)(ii)(A) and (3)(b)(ii)(B) of this Rule. Discharges which qualify for a General Permit pursuant to 15A NCAC 02H .0127, trout farm discharges, recycle (closed loop) systems that only discharge in response to 10-year storm events, other stormwater discharges and domestic wastewater discharges shall be allowed in the protected and critical areas. Treated industrial wastewater discharges are allowed in the protected and critical areas; however, new industrial wastewater discharges in the critical area shall be required to meet the provisions of 15A NCAC 02B .0224(1)(b)(iv), (v) and (vii), and 15A NCAC 02B .0203. New industrial connections and expansions to existing municipal discharges with a pretreatment program pursuant to 15A NCAC 02H .0904 are allowed. The waters, following treatment required by the Division of Environmental Health, shall meet the Maximum Contaminant Level concentrations considered safe for drinking, culinary, or food-processing purposes which are specified in the national drinking water regulations and in the North Carolina Rules Governing Public Water Supplies, 15A NCAC 18C .1500. Sources of water pollution which preclude any of these uses on either a short-term or long-term basis shall be considered to be violating a water quality standard. The Class WS-II or WS-III classifications may be used to protect portions of Class WS-IV water supplies. For reclassifications of these portions of WS-IV water supplies occurring after the July 1, 1992 statewide reclassification, the more protective classification requested by local governments shall be considered by the Commission when all local governments having jurisdiction in the affected area(s) have adopted a resolution and the appropriate ordinances to protect the watershed or the Commission acts to protect a watershed when one or more local governments has failed to adopt necessary protection measures.

(3) Quality standards applicable to Class WS-IV Waters are as follows:

(a) Sewage, industrial wastes, non-process industrial wastes, or other wastes: none shall be allowed except for those specified in Item (2) of this Rule and Rule .0104 of this Subchapter and none shall be allowed which shall have an adverse effect on human health or which are not effectively treated to the satisfaction of the Commission and in accordance with the requirements of the Division of Environmental Health, North Carolina Department of Environment and Natural Resources. Any discharges or industrial users subject to pretreatment standards may be required by the Commission to disclose all chemical constituents present or potentially present in their wastes and chemicals which could be spilled or be present in runoff from their facility which may have an adverse impact on downstream water supplies. These facilities may be required to have spill and treatment failure control plans as well as perform special monitoring for toxic substances;

(b) Nonpoint Source and Stormwater Pollution: none shall be allowed that would adversely impact the waters for use as water supply or any other designated use.

(i) Nonpoint Source and Stormwater Pollution Control Criteria For Entire Watershed or Protected Area:

(A) Low Density Option: Development activities which require a Sedimentation/Erosion Control Plan in accordance with 15A NCAC 4 established by the North Carolina Sedimentation Control Commission or approved local government programs as delegated by the Sedimentation Control Commission shall be limited to no more than either: two dwelling units of single family detached development per acre (or 20,000 square foot lot excluding roadway right-of-way) or 24 percent built-upon on area for all other residential and non-residential development; or three dwelling units per acre or 36 percent built-upon area for projects without curb and gutter street systems in the protected area outside of the critical area; Stormwater runoff from the development shall be transported by vegetated conveyances to the maximum extent practicable;

(B) High Density Option: If new development activities which require a Sedimentation/Erosion Control Plan exceed the low density requirements of Sub-Item (3)(b)(i)(A) of this Rule then development shall control the runoff from the first inch of rainfall; new residential and non-residential development shall not exceed 70 percent built-upon area;

(C) Land within the critical and protected area shall be deemed compliant with the density requirements if the following condition is met: The density of all existing development at the time of reclassification does not exceed the density requirement when densities are averaged throughout the entire area;

(D) Cluster development shall be allowed on a project-by-project basis as follows:

(I) overall density of the project meets associated density or stormwater control requirements of this Rule;

(II) buffers meet the minimum statewide water supply watershed protection requirements;

(III) built-upon areas are designed and located to minimize stormwater runoff impact to the receiving waters, minimize concentrated stormwater flow, maximize the use of sheet flow through vegetated areas, and maximize the flow length through vegetated areas;

(IV) areas of concentrated development are located in upland areas and away, to the maximum extent practicable, from surface waters and drainageways;

(V) remainder of tract to remain in vegetated or natural state;

(VI) area in the vegetated or natural state may be conveyed to a property owners association; a local government for preservation as a park or greenway; a conservation organization; or placed in a permanent conservation or farmland preservation easement;

(VII) a maintenance agreement for the vegetated or natural area shall be filed with the Register of Deeds, and;

(VIII) cluster development that meets the applicable low density option requirements shall transport stormwater runoff from the development by vegetated conveyances to the maximum extent practicable;

(E) If local governments choose the high density development option which requires engineered stormwater controls, then they shall assume ultimate responsibility for operation and maintenance of the required controls as outlined in Rule .0104 of this Subchapter;

(F) Minimum 100 foot vegetative buffer is required for all new development activities that exceed the low density option requirements as specified in Sub-Item (3)(b)(i)(A) or Sub-Item (3)(b)(ii)(A) of this Rule, otherwise a minimum 30 foot vegetative buffer for development shall be required along all perennial waters indicated on the most recent versions of U.S.G.S. 1:24,000 (7.5 minute) scale topographic maps or as determined by local government studies;

(G) No new development shall be allowed in the buffer; water dependent structures, or other structures, such as flag poles, signs and security lights, which result in only diminimus increases in impervious area and public projects such as road crossings and greenways may be allowed where no practicable alternative exists; these activities shall minimize built-upon surface area, divert runoff away from surface waters and maximize the utilization of BMPs;

(H) For local governments that do not use the high density option, a maximum of 10 percent of each jurisdiction's portion of the watershed outside of the critical area as delineated on July 1, 1995 may be developed with new development projects and expansions to existing development of up to 70 percent built-upon surface area in addition to the new development approved in compliance with the appropriate requirements of Sub-Item (3)(b)(i)(A) of this Rule. For expansions to existing development, the existing built-upon surface area shall not be counted toward the allowed 70 percent built-upon surface area. A local government having jurisdiction within the watershed may transfer, in whole or in part, its right to the 10 percent/70 percent land area to another local government within the watershed upon submittal of a joint resolution for review by the Commission. When the designated water supply watershed area is composed of public land, such as National Forest land, local governments may count the public land acreage within the designated watershed area outside of the critical area in figuring the acreage allowed under this provision. Each project shall, to the maximum extent practicable, minimize built-upon surface area, direct stormwater runoff away from surface waters and incorporate best management practices to minimize water quality impacts;

(ii) Critical Area Nonpoint Source and Stormwater Pollution Control Criteria:

(A) Low Density Option: New development activities which require a Sedimentation/Erosion Control Plan in accordance with 15A NCAC 4 established by the North Carolina Sedimentation Control Commission or approved local government programs as delegated by the Sedimentation Control Commission shall be limited to no more than two dwelling units of single family detached development per acre (or 20,000 square foot lot excluding roadway right-of-way) or 24 percent built-upon area for all other residential and non-residential development; Stormwater runoff from the development shall be transported by vegetated conveyances to the maximum extent practicable;

(B) High Density Option: If new development density exceeds the low density requirements specified in Sub-Item (3)(b)(ii)(A) of this Rule engineered stormwater controls shall be used to control runoff from the first inch of rainfall; new residential and non-residential development shall not exceed 50 percent built-upon area;

(C) No new permitted sites for land application of residuals or petroleum contaminated soils shall be allowed;

(D) No new landfills shall be allowed;

(c) MBAS (Methylene-Blue Active Substances): not greater than 0.5 mg/l to protect the aesthetic qualities of water supplies and to prevent foaming;

(d) Odor producing substances contained in sewage, industrial wastes, or other wastes: only such amounts, whether alone or in combination with other substances or waste, as will not cause taste and odor difficulties in water supplies which can not be corrected by treatment, impair the palatability of fish, or have a deleterious effect upon any best usage established for waters of this class;

(e) Chlorinated~~Phenolic~~ phenolic compounds: not greater than 1.0 ug/l ~~(phenols)~~ to protect water supplies from taste and odor problems due to chlorinated phenols shall be allowed. Specific phenolic compounds may be given a different limit if it is demonstrated not to cause taste and odor problems and not to be detrimental to other best usage;

(f) Total hardness shall not exceed 100 mg/l as calcium carbonate;

(g) Total dissolved solids shall not exceed 500 mg/l;

(h) Toxic and other deleterious substances:

(i) Water quality standards (maximum permissible concentrations) to protect human health through water consumption and fish tissue consumption for non-carcinogens in Class WS-IV waters shall be allowed as follows:

(A) Barium: 1.0 mg/l;
(B) Chloride: 250 mg/l;
(C) Manganese: 200 ug/l;
(D) Nickel: 25 ug/l;
(E) Nitrate nitrogen: 10.0 mg/l;
(F) 2,4-D: 100 ug/l;
(G) 2,4,5-TP (Silvex): 10 ug/l;
(H) Sulfates: 250 mg/l;

(ii) Water quality standards (maximum permissible concentrations) to protect human health through water consumption and fish tissue consumption for carcinogens in Class WS-IV waters shall be allowed as follows:

(A) Aldrin: ~~0.127~~0.05 ng/l;
(B) Arsenic: 10 ug/l;
(C) Benzene: 1.19 ug/l;
(D) Beryllium: ~~6.8~~7 ng/l;
(E) Carbon tetrachloride: 0.254 ug/l;
(F) Chlordane: ~~0.575~~0.8 ng/l;
(G) Chlorinated benzenes: 488 ug/l;
(H) DDT: ~~0.588~~0.2 ng/l;
(I) Dieldrin: ~~0.135~~0.05 ng/l;
(J) Dioxin: ~~0.000013~~0.000005 ng/l;
(K) Heptachlor: ~~0.208~~0.08 ng/l;
(L) Hexachlorobutadiene: ~~0.445~~0.44 ug/l;
(M) Polynuclear aromatic ~~hydrocarbons:~~hydrocarbons (total of all PAHs): 2.8 ng/l;
(N) Tetrachloroethane (1,1,2,2): ~~0.172~~0.17 ug/l;
(O) Tetrachloroethylene: ~~0.8~~0.7 ug/l;
(P) Trichloroethylene: ~~3.08~~2.5 ug/l;
(Q) Vinyl Chloride: ~~2~~0.025 ug/l.

Authority G.S. 143-214.1; 143-215.3(a)(1).

15A NCAC 02B .0218 FRESH SURFACE WATER QUALITY STANDARDS FOR CLASS WS-V WATERS

The following water quality standards apply to surface water supply waters that are classified WS-V. Water quality standards applicable to Class C waters as described in Rule .0211 of this Section also apply to Class WS-V waters.

(1) The best usage of WS-V waters are as follows: waters that are protected as water supplies which are generally upstream and draining to Class WS-IV waters or waters previously used for drinking water supply purposes or waters used by industry to supply their employees, but not municipalities or counties, with a raw drinking water supply source, although this type of use is not restricted to WS-V classification. Class WS-V waters are suitable

for all Class C uses. The Commission may consider a more protective classification for the water supply if a resolution requesting a more protective classification is submitted from all local governments having land use jurisdiction within the affected watershed; no categorical restrictions on watershed development or wastewater discharges are required, however, the Commission or its designee may apply appropriate management requirements as deemed necessary for the protection of waters downstream of receiving waters (15A NCAC 2B .0203).

(2) The conditions related to the best usage are as follows: waters of this class are protected water supplies; the waters, following treatment required by the Division of Environmental Health, shall meet the Maximum Contaminant Level concentrations considered safe for drinking, culinary, or food-processing purposes which are specified in the national drinking water regulations and in the North Carolina Rules Governing Public Water Supplies, 15A NCAC 18C .1500; sources of water pollution which preclude any of these uses on either a short-term or long-term basis shall be considered to be violating a water quality standard.

(3) Quality standards applicable to Class WS-V Waters are as follows:

(a) Sewage, industrial wastes, non-process industrial wastes, or other wastes: none which shall have an adverse effect on human health or which are not effectively treated to the satisfaction of the Commission and in accordance with the requirements of the Division of Environmental Health, North Carolina Department of Environment and Natural Resources; any discharges or industrial users subject to pretreatment standards may be required by the Commission to disclose all chemical constituents present or potentially present in their wastes and chemicals which could be spilled or be present in runoff from their facility which may have an adverse impact on downstream water supplies; these facilities may be required to have spill and treatment failure control plans as well as perform special monitoring for toxic substances;

(b) MBAS (Methylene-Blue Active Substances): not greater than 0.5 mg/l to protect the aesthetic qualities of water supplies and to prevent foaming;

(c) Nonpoint Source and Stormwater Pollution: none that would adversely impact the waters for use as water supply or any other designated use;

(d) Odor producing substances contained in sewage, industrial wastes, or other wastes: only such amounts, whether alone or in combination with other substances or waste, as will not cause taste and odor difficulties in water supplies which can not be corrected by treatment, impair the palatability of fish, or have a deleterious effect upon any best usage established for waters of this class;

(e) ~~Phenolic~~Chlorinated phenolic compounds: not greater than 1.0 ug/l ~~(phenols)~~ to protect water supplies from taste and odor problems due to chlorinated phenols; specific phenolic compounds may be given a different limit if it is demonstrated not to cause taste and odor problems and not to be detrimental to other best usage;

(f) Total hardness: not greater than 100 mg/l as calcium carbonate;

(g) Total dissolved solids: not greater than 500 mg/l;

(h) Toxic and other deleterious substances:

(i) Water quality standards (maximum permissible concentrations) to protect human health through water consumption and fish tissue consumption for non-carcinogens in Class WS-V waters:

(A) Barium: 1.0 mg/l;
(B) Chloride: 250 mg/l;
(C) Manganese: 200 ug/l;
(D) Nickel: 25 ug/l;
(E) Nitrate nitrogen: 10.0 mg/l;
(F) 2,4-D: 100 ug/l;
(G) 2,4,5-TP (Silvex): 10 ug/l;
(H) Sulfates: 250 mg/l.

(ii) Water quality standards (maximum permissible concentrations) to protect human health through water consumption and fish tissue consumption for carcinogens in Class WS-V waters:

(A) Aldrin: ~~0.127~~ 0.05 ng/l;
(B) Arsenic: 10 ug/l;

(C) Benzene: 1.19 ug/l;
(D) Beryllium: ~~6.8~~ 7 ng/l;
(E) Carbon tetrachloride: 0.254 ug/l;
(F) Chlordane: ~~0.575~~ 0.8 ng/l;
(G) Chlorinated benzenes: 488 ug/l;
(H) DDT: ~~0.588~~ 0.2 ng/l;
(I) Dieldrin: ~~0.135~~ 0.05 ng/l;
(J) Dioxin: ~~0.000013~~ 0.000005 ng/l;
(K) Heptachlor: ~~0.208~~ 0.08 ng/l;
(L) Hexachlorobutadiene: ~~0.445~~ 0.44 ug/l;
(M) Polynuclear aromatic ~~hydrocarbons:~~ hydrocarbons (total of all PAHs): 2.8 ng/l;
(N) Tetrachloroethane (1,1,2,2): ~~0.172~~ 0.17 ug/l;
(O) Tetrachloroethylene: ~~0.8~~ 0.7 ug/l;
(P) Trichloroethylene: ~~3.08~~ 2.5 ug/l;
(Q) Vinyl Chloride: ~~2~~ 0.025 ug/l.

Authority G.S. 143-214.1; 143-215.3(a)(1).

15A NCAC 02B .0220 TIDAL SALT WATER QUALITY STANDARDS FOR CLASS SC WATERS

General. The water quality standards for all tidal salt waters are the basic standards applicable to Class SC waters. Additional and more stringent standards applicable to other specific tidal salt water classifications are specified in Rules .0221 and .0222 of this Section.

(1) Best Usage of Waters. Aquatic life propagation and maintenance of biological integrity (including fishing, fish and functioning PNAs), wildlife, secondary recreation, and any other usage except primary recreation or shellfishing for market purposes.

(2) Conditions Related to Best Usage. The waters shall be suitable for aquatic life propagation and maintenance of biological integrity, wildlife, and secondary recreation; Any source of water pollution which precludes any of these uses, including their functioning as PNAs, on either a short-term or a long-term basis shall be considered to be violating a water quality standard.

(3) Quality standards applicable to all tidal salt waters:

(a) Chlorophyll a (corrected): not greater than 40 ug/l in sounds, estuaries, and other waters subject to growths of macroscopic or microscopic vegetation; the Commission or its designee may prohibit or limit any discharge of waste into surface waters if, in the opinion of the Director, the surface waters experience or the discharge would result in growths of microscopic or macroscopic vegetation such that the standards established pursuant to this Rule would be violated or the intended best usage of the waters would be impaired;

(b) Dissolved oxygen: not less than 5.0 mg/l, except that swamp waters, poorly flushed tidally influenced streams or embayments, or estuarine bottom waters may have lower values if caused by natural conditions;

(c) Floating solids; settleable solids; sludge deposits: only such amounts attributable to sewage, industrial wastes or other wastes, as shall not make the waters unsafe or unsuitable for aquatic life and wildlife, or impair the waters for any designated uses;

(d) Gases, total dissolved: not greater than 110 percent of saturation;

(e) ~~Organisms of coliform group: fecal coliforms not to exceed geometric mean of 200/100 ml (MF count) based upon at least five consecutive samples examined during any 30 day period; not to exceed 400/100 ml in more than 20 percent of the samples examined during such period; violations of the fecal coliform standard are expected during rainfall events and, in some cases, this violation is expected to be caused by uncontrollable nonpoint source pollution; all coliform concentrations are to be analyzed using the MF technique unless high turbidity or other adverse conditions necessitate the tube dilution method; in case of controversy over results the MPN 5-tube dilution method shall be used as the reference method;~~Enterococcus, including *Enterococcus faecalis, Enterococcus faecium, Enterococcus avium* and *Enterococcus gallinarium*: not to exceed a geometric mean of 35 enterococci per 100 ml based upon a minimum of five samples within any consecutive 30 days. In accordance with 33 U.S.C. 1313 (Federal Water Pollution Control Act) for purposes of beach monitoring and notification, "Coastal Recreational Waters Monitoring, Evaluation and Notification" regulations (15A NCAC 18A .3400) are hereby incorporated by reference including any subsequent amendments;

(f) Oils; deleterious substances; colored or other wastes: only such amounts as shall not render the waters injurious to public health, secondary recreation or to aquatic life and wildlife or adversely affect the palatability of fish, aesthetic quality or impair the waters for any designated uses; for the purpose of implementing this Rule, oils, deleterious substances, colored or other wastes shall include but not be limited to substances that cause a film or sheen upon or discoloration of the surface of the water or adjoining shorelines pursuant to 40 CFR ~~110.4(a)-(b);~~110.3;

(g) pH: shall be normal for the waters in the area, which generally shall range between 6.8 and 8.5 except that swamp waters may have a pH as low as 4.3 if it is the result of natural conditions;

(h) Phenolic compounds: only such levels as shall not result in fish-flesh tainting or impairment of other best usage;

(i) Radioactive substances:

(i) Combined radium-226 and radium-228: The maximum average annual activity level (based on at least four samples, collected quarterly) for combined radium-226, and radium-228 shall not exceed five picoCuries per liter;

(ii) Alpha Emitters. The average annual gross alpha particle activity (including radium-226, but excluding radon and uranium) shall not exceed 15 picoCuries per liter;

(iii) Beta Emitters. The maximum average annual activity level (based on at least four samples, collected quarterly) for strontium-90 shall not exceed eight picoCuries per liter; nor shall the average annual gross beta particle activity (excluding potassium-40 and other naturally occurring radio-nuclides) exceed 50 picoCuries per liter; nor shall the maximum average annual activity level for tritium exceed 20,000 picoCuries per liter;

(j) Salinity: changes in salinity due to hydrological modifications shall not result in removal of the functions of a PNA; projects that are determined by the Director to result in modifications of salinity such that functions of a PNA are impaired will be required to employ water management practices to mitigate salinity impacts;

(k) Temperature: shall not be increased above the natural water temperature by more than 0.8 degrees C (1.44 degrees F) during the months of June, July, and August nor more than 2.2 degrees C (3.96 degrees F) during other months and in no cases to exceed 32 degrees C (89.6 degrees F) due to the discharge of heated liquids;

(l) Turbidity: the turbidity in the receiving water shall not exceed 25 NTU; if turbidity exceeds this level due to natural background conditions, the existing turbidity level shall not be increased. Compliance with this turbidity standard can be met when land management activities employ Best Management Practices (BMPs) [as defined by Rule ~~.0202(6)~~.0202 of this Section] recommended by the Designated Nonpoint Source Agency (as defined by Rule .0202 of this Section). BMPs must be in full compliance with all specifications governing the proper design, installation, operation and maintenance of such BMPs;

(m) Toxic substances: numerical water quality standards (maximum permissible levels) to protect aquatic life applicable to all tidal saltwaters:

(i) Arsenic, total recoverable: 50 ug/l;

(ii) Cadmium: 5.0 ug/l; attainment of these water quality standards in surface waters shall be based on measurement of total recoverable metals concentrations unless appropriate studies have been conducted to translate total recoverable metals to a toxic form. Studies used to determine the toxic form or translators must be designed according to the "Water Quality Standards Handbook Second Edition" published by the Environmental Protection Agency (EPA 823-B-94-005a) or "The Metals Translator: Guidance For Calculating a Total Recoverable Permit Limit From a Dissolved Criterion" published by the Environmental Protection Agency (EPA 823-B-96-007) which are hereby incorporated by reference including any subsequent amendments. The Director shall consider conformance to EPA guidance as well as the presence of environmental conditions that limit the applicability of translators in approving the use of metal translators.

(iii) Chromium, total: 20 ug/l;

(iv) Cyanide: 1.0 ug/l;

(v) Mercury: 0.025 ug/l;

(vi) Lead, total recoverable: 25 ug/l; collection of data on sources, transport and fate of lead shall be required as part of the toxicity reduction evaluation for dischargers that are out of compliance with whole effluent toxicity testing requirements and the concentration of lead in the effluent is concomitantly determined to exceed an instream level of 3.1 ug/l from the discharge;

(vii) Nickel: 8.3 ug/l; attainment of these water quality standards in surface waters shall be based on measurement of total recoverable metals concentrations unless appropriate studies have been conducted to translate total recoverable metals to a toxic form. Studies used to determine the toxic form or translators must be designed according to the "Water Quality Standards Handbook Second Edition" published by the Environmental Protection Agency (EPA 823-B-94-005a) or "The Metals Translator: Guidance For Calculating a Total Recoverable Permit Limit From a Dissolved Criterion" published by the Environmental Protection Agency (EPA 823-B-96-007) which are hereby incorporated by reference including any subsequent amendments. The Director shall consider conformance to EPA guidance as well as the presence of environmental conditions that limit the applicability of translators in approving the use of metal translators.

(viii) Pesticides:

(A) Aldrin: 0.003 ug/l;

(B) Chlordane: 0.004 ug/l;

(C) DDT: 0.001 ug/l;

(D) Demeton: 0.1 ug/l;

(E) Dieldrin: 0.002 ug/l;

(F) Endosulfan: 0.009 ug/l;

(G) Endrin: 0.002 ug/l;

(H) Guthion: 0.01 ug/l;

(I) Heptachlor: 0.004 ug/l;

(J) Lindane: 0.004 ug/l;

(K) Methoxychlor: 0.03 ug/l;

(L) Mirex: 0.001 ug/l;

(M) Parathion: 0.178 ug/l;

(N) Toxaphene: 0.0002 ug/l.

(ix) ~~Polycholorinated biphenyls:~~<u>Polychlorinated biphenyls: (total of all PCBs and congeners identified)</u> 0.001 ug/l;

(x) Selenium: 71 ug/l;

(xi) Trialkyltin compounds: ~~0.002~~<u>0.007</u> ug/l expressed as tributyltin.

(4) Action Levels for Toxic Substances: if the Action Levels for any of the substances listed in this Subparagraph (which are generally not

bioaccumulative and have variable toxicity to aquatic life because of chemical form, solubility, stream characteristics or associated waste characteristics) are determined by the waste load allocation to be exceeded in a receiving water by a discharge under the specified low flow criterion for toxic substances (Rule .0206 in this Section), the discharger shall be required to monitor the chemical or biological effects of the discharge; efforts shall be made by all dischargers to reduce or eliminate these substances from their effluents. Those substances for which Action Levels are listed in this Subparagraph may be limited as appropriate in the NPDES permit if sufficient information (to be determined for metals by measurements of that portion of the dissolved instream concentration of the Action Level parameter attributable to a specific NPDES permitted discharge) exists to indicate that any of those substances may be a causative factor resulting in toxicity of the effluent. NPDES permit limits may be based on translation of the toxic form to total recoverable metals. Studies used to determine the toxic form or translators must be designed according to: "Water Quality Standards Handbook Second Edition" published by the Environmental Protection Agency (EPA 823-B-94-005a) or "The Metals Translator: Guidance For Calculating a Total Recoverable Permit Limit From a Dissolved Criterion" published by the Environmental Protection Agency (EPA 823-B-96-007) which are hereby incorporated by reference including any subsequent amendments. The Director shall consider conformance to EPA guidance as well as the presence of environmental conditions that limit the applicability of translators in approving the use of metal translators.

(a) Copper: 3 ug/l;
(b) Silver: 0.1 ug/l;
(c) Zinc: 86 ug/l.

Authority G.S. 143-214.1; 143-215.3(a)(1).

15A NCAC 02B .0221 TIDAL SALT WATER QUALITY STANDARDS FOR CLASS SA WATERS

The following water quality standards apply to surface waters that are used for shellfishing for market purposes and are classified SA. Water quality standards applicable to Class SC and SB waters as described in Rule .0220 and Rule .0222 of this Section also apply to Class SA waters.

(1) Best Usage of Waters. Shellfishing for market purposes and any other usage specified by the "SB" or "SC" classification;

(2) Conditions Related to Best Usage. Waters shall meet the current sanitary and bacteriological standards as adopted by the Commission for Health Services and shall be suitable for shellfish culture; any source of water pollution which precludes any of these uses, including their functioning as PNAs, on either a short-term or a long-term basis standard;

(3) Quality Standards applicable to Class SA Waters:

(a) Floating solids; settleable solids; sludge deposits: none attributable to sewage, industrial wastes or other wastes;
(b) Sewage: none;
(c) Industrial wastes, or other wastes: none which are not effectively treated to the satisfaction of the Commission in accordance with the requirements of the Division of ~~Health Services;~~Environmental Health;
(d) Organisms of coliform group: fecal coliform group not to exceed a median MF of 14/100 ml and not more than 10 percent of the samples shall exceed an MF count of 43/100 ml in those areas most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions.

Authority G.S. 143-214.1; 143-215.3(a)(1).

15A NCAC 02B .0222 TIDAL SALT WATER QUALITY STANDARDS FOR CLASS SB WATERS

The following water quality standards apply to surface waters that are used for primary recreation, including frequent or organized swimming, and are classified SB. Water quality standards applicable to Class SC waters are described in Rule .0220 of this Section also apply to SB waters.

(1) Best Usage of Waters. Primary recreation and any other usage specified by the "SC" classification;

(2) Conditions Related to Best Usage. The waters shall meet accepted sanitary standards of water quality for outdoor bathing places as specified in Item (3) of this Rule and will be of sufficient size and depth for primary recreation purposes; any source of water pollution which precludes any of these uses, including their functioning as PNAs, on either a short-term or a long-term basis shall be considered to be violating a water quality standard;

(3) Quality Standards applicable to Class SB waters:

(a) Floating solids; settleable solids; sludge deposits: none attributable to sewage, industrial wastes or other wastes;
(b) Sewage; industrial wastes; or other wastes: none which are not

effectively treated to the satisfaction of the Commission; in determining the degree of treatment required for such waters discharged into waters which are to be used for bathing, the Commission shall take into consideration quantity and quality of the sewage and other wastes involved and the proximity of such discharges to the waters in this class; discharges in the immediate vicinity of bathing areas may not be allowed if the Director determines that the waste can not be treated to ensure the protection of primary recreation;

(c) ~~Organisms of coliform group: fecal coliforms not to exceed a geometric mean of 200/100 ml (MF count) based on at least five consecutive samples examined during any 30 day period and not to exceed 400/100 ml in more than 20 percent of the samples examined during such period.~~Enterococcus, including *Enterococcus faecalis, Enterococcus faecium, Enterococcus avium* and *Enterococcus gallinarium*: not to exceed a geometric mean of 35 enterococci per 100 ml based upon a minimum of five samples within any consecutive 30 days. In accordance with 33 U.S.C. 1313 (Federal Water Pollution Control Act) for purposes of beach monitoring and notification, "Coastal Recreation Waters Monitoring, Evaluation and Notification" regulations (15A NCAC 18A .3400) are hereby incorporated by reference including any subsequent amendments.

Authority G.S. 143-214.1; 143-215.3(a)(1).

* * * * * * * * * * * * * * * * * * * *

Notice is hereby given in accordance with G.S. 150B-21.2 that the Water Pollution Control System Operator Certification Commission intends to adopt the rule cited as 15A NCAC 08G .0410, amend the rules cited as 15A NCAC 08G .0102, .0201 - .0205, .0301 - .0306, .0401 - .0409, .0501, .0503 - .0505, .0602 - .0603, .0701, .0801 - .0804, .1001, and repeal the rules cited as 15A NCAC 08G .0502, .0601, .0604, .0902, and .1101.

Proposed Effective Date: *November 1, 2006*

Public Hearing:
Date: *July 18, 2006*
Time: *10:00 am*
Location: *Archdale Building, Ground Floor Conference Room, 512 North Salisbury Street, Raleigh, NC*

Reason for Proposed Action: *Revision of Rules Regulating Certification of Water Pollution Control System Operators and related Permit Owners is proposed to improve the rules and correct previous grammar and wording errors. Amendments are for clarification, language standardization, grammar corrections, updating terminology and to better reflect current regulatory needs and improve understanding of the rules. Rule .0410 "Reciprocity Certification" is proposed for adoption to replace Rule .0601 which is to be repealed. Section .0502 is to be repealed as it is redundant and unnecessary. Rule .0604 "Conversion of Voluntary Certificates" Section is to be repealed because there are no longer any voluntary certificates. Rule .0902 Annual Reports is to be repealed as these reports are no longer utilized. Section .1100 Administrative Duties is to be repealed as this is covered by NC General Statute 90A-42 and is not needed.*

Procedure by which a person can object to the agency on a proposed rule: *A person wishing to object to the proposed rule revision may do so by submitting written response to WPCSOCC at 1618 Mail Service Center, Raleigh, NC 27699-1618 or at a Public Hearing scheduled for July 18, 2006 in the Archdale Building Ground Floor Conference Room at 512 North Salisbury Street, Raleigh, NC 27604 beginning at 10:00 am.*

Comments may be submitted to: *Paul E. Rawls, Chairman, WPCSOCC, 1618 Mail Service Center, Raleigh, NC 27699-1618, fax (919) 733-1338, email jerry.rimmer@ncmail.net*

Comment period ends: *September 1, 2006*

Procedure for Subjecting a Proposed Rule to Legislative Review: If an objection is not resolved prior to the adoption of the rule, a person may also submit written objections to the Rules Review Commission. If the Rules Review Commission receives written and signed objections in accordance with G.S. 150B-21.3(b2) from 10 or more persons clearly requesting review by the legislature and the Rules Review Commission approves the rule, the rule will become effective as provided in G.S. 150B-21.3(b1). The Commission will receive written objections until 5:00 p.m. on the day following the day the Commission approves the rule. The Commission will receive those objections by mail, delivery service, hand delivery, or facsimile transmission. If you have any further questions concerning the submission of objections to the Commission, please call a Commission staff attorney at 919-733-2721.

Fiscal Impact:
☐ **State**
☐ **Local**
☐ **Substantive** (≥$3,000,000)
☒ **None**

CHAPTER 08 - WATER POLLUTION CONTROL SYSTEM OPERATORS CERTIFICATION COMMISSION

SUBCHAPTER 08G - AUTHORITY: ORGANIZATION: STRUCTURE: DEFINITIONS

NOTICE OF PUBLIC HEARINGS

2004-2006 TRIENNIAL REVIEW OF SURFACE WATER QUALITY STANDARDS

July 24, 2006 2:00 PM Mooresville Public Library, 304 South Main Street, Mooresville, NC	July 25, 2006 2:00 PM Ground Floor Hearing Room Archdale Building 512 N. Salisbury Street Raleigh, NC	July 26, 2006 2:00 PM New Hanover County Public Library Northeast Regional Branch 1241 Military Cutoff Road Wilmington, NC

The NC Department of Environment and Natural Resources on behalf of the Environmental Management Commission (EMC) will conduct public hearings in order to receive public comments on the proposed rule amendments and variances to the surface water quality standards contained in the 15A NCAC 02B regulations.

What is the Triennial Review?

As required by the Federal Clean Water Act, every three years the NC Division of Water Quality (DWQ) initiates a public review of its surface water quality standards and variances. During these "Triennial Reviews" DWQ evaluates changes to the standards based on current US Environmental Protection Agency guidelines and regulations as well as comments received from staff, the public and other state agencies.

What is being proposed for this Triennial Review?

The Division of Water Quality has proposed rule amendments to the surface water quality standards for protection of human health. These are briefly summarized as follows: 1) A replacement of the term "Dietary Intake" with the term "Relative Source Contribution" is proposed to provide the State with the ability to incorporate the latest scientific information for accounting for other sources of chemical exposure, such as non-fish dietary intake and air, when deriving standards for non-carcinogens and non-linear carcinogens. 2) The State is proposing an update of the current fish consumption rate (FCR) to the national default fish consumption rate of 17.5 grams of fish/day. A default value of 17.5 grams/person/day is chosen to be protective of the majority of the general population. The US EPA values represent the uncooked weight intake of freshwater/estuarine finfish and shellfish. 3) Based on revised US EPA methodology and research, new cancer potency factors are available for benzene and vinyl chloride. When implemented, the standards will lower the applicable acceptable human health protective concentrations. 4) As mandated by the federal Beaches Environmental Assessment and Coastal Health Act (BEACH act) of 2000, the Division has proposed amendments to bacterial indicators in marine waters. The BEACH Act requires programs to monitor and analyze samples for microbiological indicators and to notify the public of the potential exposure to disease-causing microorganisms in coastal recreation waters. The BEACH Act also amended Section 303 of the CWA to require coastal states to adopt, in their water quality standards, EPA's published indicators for pathogens with criteria as protective as those published by EPA. The recommended bacterial indicator for coastal waters is proposed to change from fecal coliform to the EPA recommended indicator, enterococci. The Division must retain the use of a fecal coliform indicator for Class SA waters to accomplish the goals of the Food and Drug Administration criteria; therefore SA waters will have a dual indicator.

Additionally, the Division is also recommending rule amendments to aquatic life protective concentrations for Cadmium and Tributyltin. As with the human health changes, the revised aquatic life criteria reflect the latest scientific knowledge regarding the effects of the pollutants on aquatic organisms. The revised criteria are average concentrations that can be present in a water body, but should not result in unacceptable effects on aquatic organisms and their uses.

The public will have the opportunity to comment on three variances from surface water quality standards and the current thermal (temperature) variances. The three surface water standards consist of two variances from the chloride standard for Mt. Olive Pickle Company and Bay Valley Foods, LLC (formerly Dean Pickle and Specialty Products Company) (NC0001074 & NC0001970) and a variance from the color standard for Blue Ridge Paper Products (NC0000272). Information concerning these water quality standards variances can be obtained by contacting the individual named in the comment procedures.

Comment Procedures:

The EMC is interested in all comments pertaining to these proposed rule changes. It is very important that all interested and potentially affected persons or parties make their views known to the EMC whether in favor of or opposed to any and all of the proposed amendments. You may attend the public hearing and make relevant verbal comments and/or submit written comments, data or other relevant information. The Hearing Officer may limit the length of time that you may speak at the public hearing, if necessary, so that all those who wish to speak will have that opportunity.

You may also submit written comments, data or relevant information by September 1, 2006 to:

Connie Brower
DENR/Division of Water Quality Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617
Fax: (919) 715-5637
E-mail to: Connie.Brower@ncmail.net

NCDENR
DWQ PLANNING SECTION
1617 MAIL SERVICE CENTER
RALEIGH NC 27699-1617

For Additional Information:

Further details about these proposals and the proposed rule language is available for download: http://h2o.enr.state.nc.us/csu/TriRCurrent.html#TRIENNIALReview .
The current Division of Water Quality 15A NCAC 02B rules (known as the "Red Book") are located on the internet at http://h2o.enr.state.nc.us/admin/rules/documents/rb080104.pdf. Additional information or questions should be directed to Connie Brower at (919) 733-5083 extension 380.

The EMC may not adopt a rule that differs substantially from the text of the proposed rule published in the North Carolina Register unless the EMC publishes the text of the proposed different rule and accepts comments on the new text (see General Statute 150B 21.2 (g)). The proposed effective date for the final rule pursuant to this hearing process is January 1, 2007, pending US EPA approval.

In the case of inclement weather on the day of the scheduled public hearing, please contact the above telephone number for a recorded message regarding any changes to the location, day or time of the hearing.

ADDRESSEES FOR RULES REQUIRING THE GOVERNOR'S PRELIMINARY REVIEW
(Rules Affecting the Expenditures or Revenues of a Unit of Local Government)

ATTACHMENT A-4

TO: Lisa Nolen
Deputy Director
Office of the Governor
Intergovernmental Affairs
Administration Building
20301 MSC
Raleigh, NC 27699-0301

cc: Jim Blackburn
NC Association of County Commissioners
215 North Dawson St.
Raleigh, NC 27603

cc: Anita Watkins
NC League of Municipalities
215 North Dawson St.
Raleigh, NC 27603

cc: Jennifer Haygood
NC General Assembly Fiscal Research Division
Legislative Office Building
Room 619
Raleigh, NC 27603-5925

cc: Nathan Knuffman
Office of State Budget and Management
116 West Jones St.
Raleigh, NC 27603-8005

cc: Nancy Pate (cover page only)
14th Floor Archdale Building, Room 1419G
1601 Mail Service Center
Raleigh, NC 27699-1601

NOTE: *Per G.S. § 150B-21.26 and G.S. § 150B-21.4(b):*
Submit the proposed rule text, short explanation of the reason for the proposed change, a fiscal note stating the amount of increase or decrease in revenues and an explanation of how the amount was computed at least 30 days prior to publishing in the NC Register.

Revised 11/29/2005

DENR
ROLINA DEPARTMENT OF AND NATURAL RESOURCES

N.C. Department of Environment and Natural Resources

Release: IMMEDIATE
Date:

Contact: Susan Massengale
Phone: (919) 733-7015 ext.227

PUBLIC HEARINGS SCHEDULED TO REVIEW WATER QUALITY STANDARDS

RALEIGH – The Environmental Management Commission has scheduled three public hearings to collect public input for the 2006 Triennial Review of surface water standards - the rules that serve as the basis for protecting streams, rivers, lakes and other surface waterbodies from pollution.

Water quality standards are used to determine if the designated uses of a waterbody (i.e. swimming, fish consumption, water supply) are being protected. They are also used to determine the limits on what an industrial, community or other waste treatment facility can discharge to a waterway to preserve its uses. Under the federal Clean Water Act, states are required to review water quality standards and classifications every three years and make whatever modifications are necessary to meet U. S. Environmental Protection Agency guidance or protect waters of the state. In addition, the review takes a look at variances to water quality standards that may be requested or updated.

Hearings on the 2006 Triennial Review are scheduled:

- July 24, 2 p.m., Mooresville Public Library, 304 South Main St., Mooresville,
- July 25, 2 p.m., Ground Floor Hearing Room, Archdale Building, 512 N. Salisbury St., Raleigh, and
- July 26, 2 p.m., New Hanover County Public Library, Northeast Regional Branch, 1241 Military Cutoff Road, Wilmington.

Among the amendments the Division of Water Quality has proposed to the to the current surface water standards are to:

- update the fish consumption criteria to match the national default fish consumption rate;
- revise the standard for determining potential exposure to disease-causing microorganisms in coastal waters and
- replace the term "dietary intake" with "relative source contribution" to allow the state to take in account other sources of chemical exposure such as non-fish dietary intake.

For more information about all DWQ's proposals and proposed rule language, please visit the DWQ Web site: http://h2o.enr.state.nc.us/csu/TriRCurrent.html#TRIENNIALReview.

The comment period for the Triennial Review ends Sept.1. Both verbal and written comments, including data or other relevant information, are welcome at the public hearings. Written comments also may be submitted to: Connie Brower, DWQ Planning Section, 1617 Mail Service Center, Raleigh, NC 27699-1617; by fax to: (919) 715-5637, or by e-mail to: connie.brower@ncmail.net.

#####

A-103

Subject: [Fwd: PUBLIC HEARINGS SCHEDULED TO REVIEW WATER QUALITY STANDARDS]
From: susan massengale <susan.massengale@ncmail.net>
Date: Mon, 17 Jul 2006 13:50:53 -0400
To: DWQ Clips <DENR.DWQ_Clips.DWQ@ncmail.net>

Subject: PUBLIC HEARINGS SCHEDULED TO REVIEW WATER QUALITY STANDARDS
From: Diana Kees <diana.kees@ncmail.net>
Date: Mon, 17 Jul 2006 13:49:05 -0400
To: undisclosed-recipients:;

Michael F. Easley, Governor William G. Ross Jr., Secretary

N.C. Department of Environment and Natural Resources

Release: IMMEDIATE Contact: Susan Massengale
Date: July 17, 2006 Phone: (919) 733-7015 ext.227

PUBLIC HEARINGS SCHEDULED TO REVIEW WATER QUALITY STANDARDS

RALEIGH – The Environmental Management Commission has scheduled three public hearings to collect public input for the 2006 Triennial Review of surface water standards — the rules that serve as the basis for protecting streams, rivers, lakes and other surface waterbodies from pollution.

Water quality standards are used to determine if the designated uses of a waterbody (i.e. swimming, fish consumption, water supply) are being protected. They are also used to determine the limits on what an industrial, community or other waste treatment facility can discharge to a waterway to preserve its uses. Under the federal Clean Water Act, states are required to review water quality standards and classifications every three years and make whatever modifications are necessary to meet U. S. Environmental Protection Agency guidance or protect waters of the state. In addition, the review takes a look at variances to water quality standards that may be requested or updated.

Hearings on the 2006 Triennial Review are scheduled:

- July 24, 2 p.m., Mooresville Public Library, 304 South Main St., Mooresville;
- July 25, 2 p.m., Ground Floor Hearing Room, Archdale Building, 512 N. Salisbury St., Raleigh; and
- July 26, 2 p.m., New Hanover County Public Library, Northeast Regional Branch, 1241 Military Cutoff Road, Wilmington.

Among the amendments the Division of Water Quality has proposed to the current surface water standards are to:

- update the fish consumption criteria to match the national default fish consumption rate;
- revise the standard for determining potential exposure to disease-causing microorganisms in coastal waters; and
- replace the term "dietary intake" with "relative source contribution" to allow the state to take into account other sources of chemical exposure such as non-fish dietary intake.

For more information about all DWQ's proposals and proposed rule language, please visit the DWQ Web site: http://h2o.enr.state.nc.us/csu/TriRCurrent.html#TRIENNIALReview.

The comment period for the Triennial Review ends Sept.1. Both verbal and written comments, including data or other relevant information, are welcome at the public hearings. Written comments also may be submitted to: Connie Brower, DWQ Planning Section, 1617 Mail Service Center, Raleigh, NC 27699-1617; by fax to: (919) 715-5637, or by e-mail to: connie.brower@ncmail.net.

#####

--
Diana Kees
Director of Communications
Office of Public Affairs
N.C. Dept. of Environment and Natural Resources

1601 MSC, Raleigh, NC 27699-1601
(919) 715-4112; fax (919) 715-5181

A-104

PUBLIC HEARINGS SCHEDULED TO REVIEW WATER QUALITY STANDARDS	Content-Type: message/rfc822 Content-Encoding: 7bit

ATTACHMENT A-6

Beryllium and compounds (CASRN 7440-41

Toxicological Review (PDF) Available

Search IRIS by Keyword
go
List of IRIS Substances
Full IRIS Summaries/Toxicological Reviews
Entire IRIS Website

Health assessment information on a chemical substance is included in IRIS only after a comprehensive review of toxicity data by U.S. EPA health scientists from several Program Offices, Regional Offices, and the Office of Research and Development.

Disclaimer: This QuickView represents a snapshot of key information. We suggest that you read the Full IRIS Summary to put this information into complete context.

For definitions of terms in the IRIS Web site, refer to the IRIS Glossary.

Status of Data for Beryllium and compounds

File First On-Line: 01/31/1987
Last Significant Revision: 04/03/1998

Category	Status	Last Revised
Oral RfD Assessment	On-line	04/03/1998
Inhalation RfC Assessment	On-line	04/03/1998
Carcinogenicity Assessment	On-line	04/03/1998

Chronic Health Hazard Assessments for Noncarcinogenic Effects

Reference Dose for Chronic Oral Exposure (RfD)

Critical Effect	Point of Departure	UF	MF	RfD
Small intestinal lesions	BMD_{10} : 0.46 mg/kg-day	300	1	2×10^{-3} mg/kg-day

The Point of Departure listed serves as a basis from which the Oral RfD was derived. See Discussion of Conversion Factors and Assumptions for more details.

Principal Study
Dog dietary study, Morgareidge et al., 1976

Confidence in the Oral RfD
Study -- Medium
Database -- Low/Medium
RfD -- Low/Medium

Reference Concentration for Chronic Inhalation Exposure (RfC)

Critical Effect	Point of Departure	UF	MF	RfC
Beryllium sensitization and progression to CBD	LOAEL (HEC): 0.0002 mg/m3	10	1	2×10^{-5} mg/m3

The Point of Departure listed serves as a basis from which the Inhalation RfC was derived. See Discussion of Conversion Factors and Assumptions for more details.

Principal Study
Occupational study, Kreiss et al., 1996

Confidence in the Inhalation RfC
Study -- Medium
Database -- Medium
RfC -- Medium

Carcinogenicity Assessment for Lifetime Exposure

Weight of Evidence Characterization

Weight of Evidence (1986 US EPA Guidelines):
B1 (Probable human carcinogen - based on limited evidence of carcinogenicity in humans)

Weight of Evidence Narrative:
Using the 1996 proposed Guidelines for Carcinogen Risk Assessment, inhaled beryllium would be characterized as a "likely" carcinogen in humans, and the human carcinogenic potential of ingested beryllium cannot be determined. *

This may be a synopsis of the full weight-of-evidence narrative. See Full IRIS Summary.

Quantitative Estimate of Carcinogenic Risk from Oral Exposure

Information reviewed but value not estimated. Refer to Full IRIS Summary. *

Quantitative Estimate of Carcinogenic Risk from Inhalation Exposure

Air Unit Risk(s)	Extrapolation Method
$2.4x10^{-3}$ per ug/m3	Relative risk

Air Concentrations at Specified Risk Levels

Risk Level	Concentration
E-4 (1 in 10,000)	$4x10^{-2}$ ug/m3
E-5 (1 in 100,000)	$4x10^{-3}$ ug/m3
E-6 (1 in 1,000,000)	$4x10^{-4}$ ug/m3

Dose-Response Data (Carcinogenicity, Inhalation Exposure)
Tumor Type: Lung cancer
Test Species: Human, male
Route: Inhalation, Occupational exposure
Reference: Wagoner et al., 1980

Revision History

Review Full IRIS Summary for complete Revision History.

Synonyms

7440-41-7
Beryllium
Beryllium-9
Glucinum
RCRA Waste Number p015
UN 1567
Beryllium and compounds

AGEMENT COMMISSION

NORTH CAROLINA
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

July 12, 2006

MEMORANDUM

TO: DIANNE REID,
DIVISION OF WATER QUALITY

FROM: DAVID H. MOREAU

SUBJECT: HEARING OFFICER APPOINTMENT

I hereby appoint you to serve as hearing officer for public hearings to be held for the Triennial Review of Surface Water Quality Standards. Proposed changes to 15A NCAC 2B regulations will be presented to the interested public by staff of the Planning Section of the Division of Water Quality. The public hearings are scheduled for July 24th at 2:00 pm in Mooresville, July 25th at 2:00 PM in Raleigh and July 26th at 2:00 PM in Wilmington. Please see the attached public announcement with further details. Connie Brower (733-5083, ext. 380) will provide staff support for you. Please present your findings and recommendations to the Environmental Management Commission. Thank you for your assistance and service.

Attachment: Public Announcement

cc: Coleen Sullins
Hearing Record File

Individuals Attending the July 24, 2006 Public Hearing, Mooresville, NC

Hearing Officer
Dianne Reid

Participating Staff Members
Connie Brower
Jason Wynn
David Hill

US EPA Officials
Lisa Perras-Gordon, Region IV – Atlanta, GA
Jessica Lewis, Region IV – Atlanta, GA

Public Attendance

Nicole Johnston	Town of Mooresville
Mike Lamberth	Town of Mooresville
Ron Lewis	Duke Energy
Dawn Padgett	City of Charlotte, CMU
Toni Norton	Catawba County

Staff of the Division of Water Quality

Dee Browder	Mooresville Regional Office

Individuals Attending the July 25, 2006 Public Hearing, Raleigh, NC

Hearing Officer
Dianne Reid

Participating Staff Members
Connie Brower
Jason Wynn
David Hill

US EPA Officials
Lisa Perras-Gordon
Jessica Lewis

Public Attendance

Tammy Hill	
Jeff Mahayan	
B. Brock	
Amy Pickle	Southern Environmental Law Center
Heather Jacobs	Pamlico-Tar River Foundation
Carolina Barnett-Loro	Pamlico-Tar River Foundation
Tom Augspurger	US Fish and Wildlife Service
Martha Groome	City of Greensboro
Sharon Miller	City of Greensboro
John Cratch	Town of Apex
David Hardin	Town of Apex
Leon Holt	Town of Cary
Andy McDaniel	NC Dept. of Transportation
Bob Holman	NC Dept. of Transportation
Tom Hill	Wake County
Brian Jacobson	URS
T.J. Lynch	City of Raleigh
Marla Dalton	City of Raleigh
Mick Greeson	Progress Energy
James Joyner	TRC Env. Corp

Staff of the Division of Water Quality

Susan Massengale	Public Information Officer
Kent Wiggins	Chemistry Laboratory
Roy Byrd	Chemistry Laboratory
Ellen Stafford	Chemistry Laboratory
Carol Hollenkamp	Chemistry Laboratory
Ray Boling	Chemistry Laboratory
Jennie Atkins	Environmental Sciences Section
Matt Matthews	Point Source Branch
Susan Wilson	NPDES -West
Gil Vinzani	NPDES – East
Tom Belnick	NPDES
Sergei Cherikov	NPDES
Teresa Rodriquez	NPDES
Vanessa Manuel	NPDES

Individuals Attending the July 25, 2006 Public Hearing, Raleigh, NC (Continued)

Staff of the Division of Water Quality

Frances Candelaria	NPDES
Bob Guerra	NPDES
Agyeman Adu-Poku	NPDES
Dana Rees Folley	PERCS
Bethany Georgoulias	Storm Water Permitting Unit
Nora Deamer	Planning Section
Michelle Raquet	Planning Section

Individuals Attending the July 26, 2006 Public Hearing, Wilmington NC

Hearing Officer
Dianne Reid

Participating Staff Members
Connie Brower
Jason Wynn
David Hill

US EPA Officials
Lisa Perras-Gordon
Jessica Lewis

Public Attendance

Layton Bedsole	NC Ports
Rosalie Howell	
Delores Bradshaw	City of Wilmington
Jerry Panz	Wilmington Regional Assoc. of Realtors
Ed Kreul	International Paper
Deb Quaranta	Wilmington Regional Assoc. of Realtors
Diana Rashash	NC Cooperative Extension
Ken Vogt	City of Wilmington
Jim Spangler	Spangler Environmental

Public Hearings:
Triennial Review of Surface **ifications 2004 - 2006**
Mooresville, Raleigh, and Wilmington, North Carolina
July 24, 25 and 26th, 2006

Hearing Officer: Dianne Reid, Supervisor, Intensive Survey Unit, Environmental Sciences Section, Division of Water Quality

Good afternoon. This public hearing is now officially called to order.

My name is Dianne Reid. I have been appointed by the Environmental Management Commission of the Department of Environment and Natural Resources as the designated hearing officer for today's hearing.

This hearing is being held under the authority of North Carolina General Statutes, Chapter 143-214.1 and 143-215.3(a). In accordance with the General Statutes, a public notice of this hearing was published in the July 1, 2006 edition of the *North Carolina Register*. Additionally, notices were also sent to local government officials, as well as other persons thought to be interested in today's hearings and those who have requested to be placed on the water quality rule-making mailing list and e-mail notification list. Notice to the public was also provided through the Division's website and a press release was issued by the Division of Water Quality on Monday, July 17th.

The purpose of this Hearing is to obtain public comment on proposed modifications to the regulations governing surface water quality standards. Every three years the State is required by the Federal Clean Water Act to review its surface water quality standards and classifications to determine if changes are needed and, if necessary, to make those changes. This process is known as the Triennial Review. The Federal Clean Water Act also requires the review of variances from surface water quality standards at least every three years. The rule changes proposed as part of this public hearing and the variances being presented are being put forth as part of North Carolina's Triennial Review of surface water quality standards and classifications.

There are copies of the proposed rule changes available at the registration table that describes this proposal in greater detail. The purpose of this hearing is to obtain public comment on the variances and proposed rules. Please understand that your comments are important and will be used in developing recommendations to the Environmental Management Commission regarding how to proceed.

A written record of this hearing will be prepared which will include all the relevant comments, questions and discussions. For this reason, the hearing is being tape-recorded. Written comments received by September 1, 2006 will also be included in the record.

Based on public comments and analysis by myself and the Water Quality staff, I will make a recommendation to the Environmental Management Commission. The recommendation for the proposed rules may be to adopt the proposed rules or to adopt a modified version of the proposal, or to take no action. We may not recommend a rule that differs substantially from the text of the proposed rule unless the EMC publishes the text with modifications and then holds another public hearing.

In making the final decision, the Environmental Management Commission considers the written record, the recommendation of the hearing officer and any concerns of the other commission members.

At this time, I will recognize some government officials that are here tonight:

Ms Lisa Perras-Gordon, US EPA – Region IV, Atlanta GA

Ms. Jessica Lewis US EPA –Region IV, Atlanta, GA

Insert appropriate names

Is there anyone I missed?

Thank you. Let's also recognize members of the staff of the Division of Water Quality present:

Connie Brower, Water Quality Standards Coordinator for the Division,

Jason Wynn, Environmental Chemist, DWQ and

Dave Hill, Technical Assistant for Classifications and Standards.

Insert appropriate names

Is there anyone I missed? Thank you.

Now, Connie Brower will present a brief overview of the proposed rule changes and the variances. After Connie's presentation, comments from the audience will be allowed.

<Connie's presentation>

Thank you, Connie. The Environmental Management Commission is very interested in all comments pertaining to the proposed rules and the variances. It is very important that all interested and potentially affected persons or parties make their opinion known to the Commission, whether in favor of or opposed to any or all provisions of the proposed rule. All interested and potentially affected persons are strongly encouraged to read the notice and information package, and to make appropriate comments on the proposal presented here tonight. Your comments are important and will enable the Commission to act in the best interest of the public.

We will now accept comments from the audience. If you have written copies of your comments, please give us a copy. We may question speakers if the need arises. When your name is called, please come up to the microphone and state your name and any business or group affiliation. If you have not already done so, and you would like to speak, please be sure to sign the registration form at the registration table. After all registered speakers have had an opportunity to comment, I will allow comments from additional speakers if time permits. DWQ staff will be available after the hearing to answer any questions that you may have.

<<<(*if a large number of people have requested to speak, i.e.*

# People who wish to speak	***Time limit per speaker*
1-20	*None*
21-30	*4 minutes*
31+	*3 minutes*

(*insert the following if necessary*) Because a large number of people have requested to speak, it will be necessary to impose a time limit of ______(*** see above choice of 3 or 4*) minutes. We appreciate your cooperation with this time limit so that everyone who wishes to speak is able to do so.)>>>

I will now call on the first speaker. (*call speakers in the order that they registered*

<if there is time> Are there any additional comments?

If there are no more comments, I declare the hearing closed.

<if there isn't time for additional comments> I declare this hearing closed. The hearing record will remain open until September 1, 2006. That means that anytime between tonight and Close of business on September 1, 2006, anyone can submit further comments on the proposed rules in writing. Written comments received by US Mail or by e-mail during this time period will be made a

part of the public record. (the last slide of the presentation will have both addresses for you to reference)

After the comment period has ended, we will present our recommendations to the Environmental Management Commission at their November meeting. As I noted earlier, the Commission may not make substantial changes in the final rules without re-notice and rehearing. If the Commission adopts the proposed rules, then the expected effective date for the rules would be January 1, 2007. We thank everyone for being here today and offering your comments. Staff will be around for a few minutes to answer any additional questions you might have. Thank you for attending.

ATTACHMENT A-10

Subject: NC Pretreatment Consortium dard Change
From: "Padgett, Dawn" <DPadgett@ci.
Date: Mon, 4 Sep 2006 14:24:30 -0400
To: <connie.brower@ncmail.net>
CC: <martie.groome@ci.greensboro.nc.us>

Ms. Brower, On Friday September 1, 2006, the NC Pretreatment Consortium submitted a comment on the NC DWQ Proposed Cadmium limit revision. Attached to this e-mail, please find copies of the Chadwick Ecological Consultants response to the EPA 2001 Update of Ambient Water Quality Criteria that is sited in our comments, dated September, 2004 and a response to the EPA comments to that paper also from Chadwick Ecological Consultants dated December, 2004.

The original comments were sent from Martie Groome, Chairman of the NC Pretreatment Consortium, the attached documents are being sent to you as a reference to that document. A hard copy of the comments along with this and other reference material is being sent to you office.

Thank you for the opportunity to make these comments.

Dawn K. Padgett
NC Pretreatment Consortium
Triennial Review Committee <<Cd WQ Crit Review 904.pdf>> <<CadCritRevision 1204 (2).pdf>>
704/357-1344, ext. 235

Cd WQ Crit Review 904.pdf	**Content-Description:**	Cd WQ Crit Review 904.pdf
	Content-Type:	application/octet-stream
	Content-Encoding:	base64

CadCritRevision 1204 (2).pdf	**Content-Description:**	CadCritRevision 1204 (2).pdf
	Content-Type:	application/octet-stream
	Content-Encoding:	base64

DATE: 9-1-2006

TO: CONNIE BROWER
(919) 715-5637

FROM: NC PRETREATMENT CONSORTIUM
Martie Groome, Chair

RE: PROPOSED CHANGE IN CADMIUM WATER QUALITY STANDARD

Connie,

The City of Greensboro email system is currently down. Thus, I am faxing the following items to you:

1. NC Pretreatment Consortium Statement [5 pages]
2. Cadmium Maximum Allowable Headworks Loading Comparisons [1 page]
3. NC Pretreatment Consortium Public Hearing Comments Raleigh 7-25-2006 [4 pages]

Two other attachments to our comments will be emailed to you before Tuesday, September 5, 2006. They are as follows:

1. Chadwick Ecological Consultants, Inc. "U.S. EPA Cadmium Criteria Documents-Technical Review and Criteria Update" (September 2004)
2. Chadwick Ecological Consultants, Inc. "Addendum to U.S. EPA Cadmium Criteria Documents-Technical Review and Criteria Update" (December 2004)

U.S. EPA CADMIUM WATER QUALITY CRITERIA DOCUMENT – TECHNICAL REVIEW AND CRITERIA UPDATE

SEPTEMBER 2004

Chadwick Ecological Consultants, Inc.

5575 S. Sycamore St., Suite 101, Littleton, CO 80120
Ph: (303) 794-5530 Fax: (303) 794-5041 Chadeco@aol.com

TABLE OF CONTENTS

The fourth phase included the calculation of potential "use-specific" cadmium criteria for freshwater organisms. Specifically, acute and chronic cadmium AWQC were developed for cold and warmwater uses based on the expected distribution of the species in each database. These calculations could potentially supersede the general AWQC for cadmium when it can be demonstrated that a particular stream can be classified exclusively as either cold or warmwater.

REVIEW OF 2001 CADMIUM WATER QUALITY CRITERIA UPDATE

Phase 1 - Technical Review of 2001 Cadmium Update

Phase 1 of CEC's evaluation of the 2001 Cadmium Update consisted of a thorough investigation of the data used to calculate the most recent cadmium criteria. The document (U.S. EPA 2001) was critically reviewed for relevance of the toxicological data and adherence to U.S. EPA methodology (Stephan *et al.* 1985). The criteria presented in the 2001 Cadmium Update supersede previous 1995 AWQC update for cadmium (U.S. EPA 1996), which was built upon the 1984 criteria (U.S. EPA 1984) and principles set forth in the 1985 Guidelines (Stephan *et al.* 1985). Some general principles presented in the 1985 Guidelines include:

(1) Acute toxicity data must be available for species from a minimum of eight diverse families (the family Salmonidae, a second family in the class Osteichthyes, a third family in the phylum Chordata, a planktonic crustacean, a benthic crustacean, an insect, a family in a phylum other than Arthropoda or Chordata, and a family in any order of insect or any phylum not already represented).

(2) The final acute value (FAV) is derived by extrapolation or interpolation to a hypothetical genus more sensitive than 95 percent of all tested genera. The FAV is divided by two in order to obtain an acute criterion protective of nearly all individuals in the database.

(3) Chronic toxicity data must be available for at least three taxa. The chronic criterion is most often set by determining an appropriate acute-chronic ratio (the ratio of acutely toxic concentrations to the chronically toxic concentrations for the same species) and dividing the FAV by that ratio. However,

Additionally, data was used from a study conducted by Attar and Maly (1982) that examined the toxicity of cadmium, zinc, and their mixtures to *Daphnia magna*. CEC determined these data unsuitable for use in AWQC derivations because of inappropriate treatment of test organisms. *D. magna* test organisms were cultured in a 430 L polyethylene tub containing a concentrated algae culture. Water quality analyses of the culture water showed that the water contained trace amounts of cadmium (1.0 µg/L) and iron (3 µg/L). This concentration of cadmium may seem insignificant, however the species mean chronic value for *D. magna* is < 0.3794 µg/L according to the 2001 Cadmium Update. Therefore, we determined these conditions constitute "previous exposure to cadmium," and data from this study were removed from the revised acute cadmium database.

Finally, data from Sunderman *et al.* (1991) for the African clawed frog (*Xenopus laevis*) were used in the acute criteria development in the 2001 Cadmium Update. CEC determined these data unsuitable because *X. laevis* is not native to North America. In fact, its distribution in North America is restricted to isolated regions in the southwestern U.S. where it was accidentally introduced and is considered a pest species.

After data from the aforementioned publications were removed from the acute database, the resultant acute database consists of 64 species occupying 54 genera. Only one species (*X. laevis*) constituting the entire data set for its genus was removed entirely from the revised acute database. The "eight-family rule" is still met by this database according to the 1985 Guidelines.

Chronic Toxicity

The 2001 Cadmium Update presents chronic data for 16 genera of freshwater organisms, including seven species of invertebrates and 14 species of fishes. These 21 species satisfy the "eight-family rule" as specified in the 1985 Guidelines. With regard to data review, only the chronic *D. magna* data from the unpublished Chapman *et al.* manuscript was determined to be unsuitable for use in cadmium AWQC derivation for two reasons (Table 1). First, the document we obtained through the U.S. EPA's document coordinator is a rough manuscript with very little details regarding the methodology. More specifically, the no-observed-effect-concentrations (NOEC) and lowest-observed-effect-concentrations (LOEC) that are typically used to calculate chronic values were not clearly defined, the methods used for calculating chronic values were not presented, and the underlying data were not reported. Additionally, the Chapman *et al.* data are roughly an reported in this study for *Ceriodaphnia dubia*, *D. magna*, *Pimephales promelas*, *Hyalella azteca*, and *Chironomus tentans* and were incorporated into the revised acute database. The other study not mentioned in the 2001 Cadmium Update is an internal report published by the CDOW in which brown trout (*Salmo trutta*) were exposed to various concentrations of cadmium sulfate in a static renewal toxicity test (Davies and Brinkman 1994). One acute value for *S. trutta* was utilized from this study.

TABLE 2: Acute cadmium toxicity data added to the acute database.

Species	Method[a]	Chemical	Hardness (mg/L)	LC_{50} (µg/L)	Adjusted LC_{50}[b]	Reference
Ceriodaphnia dubia	S, M, T	$CdCl_2$	17	63.01	167.67	Suedel *et al.* 1997
Daphnia magna	S, M, T	$CdCl_2$	17	26.40	70.15	Suedel *et al.* 1997
Pimephales promelas	S, M, T	$CdCl_2$	17	4.80	12.75	Suedel *et al.* 1997
*Hyalella azteca**	S, M, T	$CdCl^2$	17	2.80	7.44	Suedel *et al.* 1997
*Chironomus tentans***	S, M, T	$CdCl_2$	17	2,956.00	7,854.85	Suedel *et al.* 1997
Salmo trutta	R, M, T	$CdSO_4$	37.6	2.37	3.07	Davies and Brinkman 1994
*Thymallus arcticus** (juvenile)	S, M, T	$CdCl_2$	41	4.00	4.79	Buhl and Hamilton 1991
Oncorhynchus mykiss	R, M, T	$CdCl_2$	420 (388-490)	7.40	1.08	Davies *et al.* 1993
Oncorhynchus mykiss	R, M, T	$CdCl_2$	427 (406-444)	5.92	0.85	Davies *et al.* 1993
Oncorhynchus mykiss	R, M, T	$CdCl_2$	217 (203-240)	4.20	1.11	Davies *et al.* 1993
Oncorhynchus mykiss	R, M, T	$CdCl_2$	227 (212-243)	6.57	1.67	Davies *et al.* 1993
Oncorhynchus mykiss	R, M, T	$CdCl_2$	46 (45-48)	2.64	2.85	Davies *et al.* 1993
Oncorhynchus mykiss	R, M, T	$CdCl_2$	49 (48-50)	3.08	3.14	Davies *et al.* 1993
*Chironomus plumosus***	S, U	$CdCl_2$	80	12,700.00	8,296.43	Fargasova 2003

[a] S = static, R = renewal, M = measured, U = unmeasured, and T = total measured concentration.
[b] Value adjusted to hardness = 50 using the revised acute slope (0.9059) listed in Table 6.
* New genus.
** New species.

There are three studies listed in Table 6a ("Other Data") in the 2001 Cadmium Update that we believe provide useful data. One data point for the arctic grayling (*Thymallus arcticus*) from Buhl and Hamilton (1991) was added to the revised acute cadmium database. The data point is listed in Table 6a of the 2001

TABLE 3: Chronic cadmium toxicity data added to the chronic database.

Species	Method[a]	Chemical	Hardness (mg/L)	Chronic Value (µg/L)	Adjusted Chronic Value[b]	Reference
Ceriodaphnia dubia	LC	$CdCl_2$	17.0	2.00	4.59	Suedel *et al.* 1997
Salmo trutta	ELS	$CdSO_4$	39.8	1.33	1.58	Davies and Brinkman 1994
Daphnia magna	LC	$CdCl_2$	209.2	0.69	0.23	Canton and Slooff 1982
Oncorhynchus mykiss	LC	$CdCl_2$	46.2 (45-48)	1.47	1.56	Davies *et al.* 1993
Oncorhynchus mykiss	LC	$CdCl_2$	217.0 (203-240)	3.58	1.17	Davies *et al.* 1993
Oncorhynchus mykiss	LC	$CdCl_2$	413.8 (383-438)	3.64	0.73	Davies *et al.* 1993
Hyalella azteca	ELS	$CdCl_2$	280.0	1.40	0.38	Ingersoll and Kemble 2001
Daphnia magna	LC	$CdCl_2$	51.0	2.07	2.04	CEC 2003
Daphnia magna	LC	$CdCl_2$	99.0	2.23	1.32	CEC 2003
Daphnia pulex	LC	$CdCl_2$	52.0	2.17	2.17	CEC 2003
Hyalella azteca	ELS	$CdCl_2$	153.0	0.76	0.32	CEC 2003
Hyalella azteca	ELS	$CdCl_2$	126.0	0.50	0.25	CEC 2003

[a] ELS = early life stage and LC = life cycle or partial life cycle.
[b] Value adjusted to hardness = 50 using the revised chronic slope (0.7635) found in Table 8.

Two data sources (Canton and Slooff 1982 and Davies *et al.* 1993) were listed in Table 6a (Other Data) of the 2001 Cadmium Update as unused data for acute data points. However, both of these papers contain chronic data in addition to acute data. Chronic data from these papers are not mentioned in Table 2a (Chronic Toxicity of Cadmium to Freshwater Animals) or Table 6a. We determined three rainbow trout data points (Davies *et al.* 1993) and one *D. magna* data point (Canton and Slooff 1982) were suitable for use and added these data to the revised chronic database. Finally, chronic cadmium tests were conducted by C&A on behalf of TCMC using three freshwater species, including *D. pulex*, *D. magna*, and *H. azteca* (CEC 2003). Chronic values from these tests were added to the revised chronic database.

Phase 3 - Updated Cadmium Criteria Analysis

After excluding inappropriate data used in the 2001 Cadmium Update and adding data deemed suitable for inclusion from our literature review, revised acute (Table 4) and chronic (Table 5) databases were

TABLE 4: Revised acute cadmium criteria database.

Rank	Species	GMAV (µg/L)	SMAV (µg/L)	Common Name	Family	Code
56	*Chironomus riparius*	19,256.25	109,568.59	Midge	Chironomidae	1, 2
	Chironomus tentans		7,854.85	Midge	Chironomidae	1, 2
	Chironomus plumosus		8,296.43	Midge	Chironomidae	1, 2
55	*Dendrocoelum lacteum*	14,956.11	14,956.11	Planaria	Planariidae	1, 2
54	*Orconectes virilis*	>11,193.54	11,030.68	Crayfish	Cambaridae	1, 2
	Orconectes immunis		>11,358.81	Crayfish	Cambaridae	1, 2
53	*Oreochromis mossambica*	10,015.83	10,015.83	Tilapia	Cichlidae	2
52	*Gasterosteus aculeatus*	5,940.39	5,940.39	Threespine stickleback	Gasterosteidae	2
51	*Gambusia affinis*	5,501.38	5,501.38	Mosquitofish	Poeciliidae	2
50	*Ictalurus punctatus*	4,988.97	4,988.97	Channel catfish	Ictaluridae	2
49	*Lepomis cyanellus*	4,869.13	3,659.42	Green sunfish	Centrarchidae	2
	Lepomis macrochirus		6,478.72	Bluegill	Centrarchidae	2
48	*Rhyacodrilus montana*	4,811.89	4,811.89	Tubificid worm	Tubificidae	1, 2
47	*Cyprinus carpio*	4,576.46	4,576.46	Common carp	Cyprinidae	2
46	*Stylodrilus heringianus*	4,200.86	4,200.86	Tubificid worm	Tubificidae	1, 2
45	*Notropis lutrensis*	4,071.80	4,071.80	Red shiner	Cyprinidae	2
44	*Spirosperma ferox*	3,031.21	2,673.27	Tubificid worm	Tubificidae	1, 2
	Spirosperma nikolskyi		3,437.07	Tubificid worm	Tubificidae	1, 2
43	*Varichaeta pacifica*	2,902.41	2,902.41	Tubificid worm	Tubificidae	1, 2
42	*Jordanella floridae*	2,806.94	2,806.94	Flagfish	Cyprinodontidae	1, 2
41	*Catostomus commersoni*	2,800.71	2,800.71	White sucker	Catostomidae	1, 2
40	*Poecilia reticulata*	2,579.10	2,579.10	Guppy	Poeciliidae	2
39	*Quistradilus multisetosus*	2,444.14	2,444.14	Tubificid worm	Tubificidae	1, 2
38	*Ephemerella grandis*	2,245.55	2,245.55	Mayfly	Ephemerellidae	1, 2
37	*Branchiura sowerbyi*	1,833.10	1,833.10	Tubificid worm	Tubificidae	1, 2
36	*Crangonyx pseudogracilis*	1,700.00	1,700.00	Amphipod	Crangonyctidae	1, 2
35	*Procambarus clarkii*	1,651.99	1,651.99	Crayfish	Cambaridae	1, 2

TABLE 4: Continued.

Rank	Species	GMAV (µg/L)	SMAV (µg/L)	Common Name	Family	Code
9	*Daphnia magna*	27.62	15.49	Cladoceran	Daphnidae	1, 2
	Daphnia pulex		49.26	Cladoceran	Daphnidae	1, 2
8	*Simocephalus serrulatus*	27.58	27.58	Cladoceran	Daphnidae	1, 2
7	*Ptychocheilus lucius**	26.26	26.26	Colorado pikeminnow	Cyprinidae	2
	Ptychocheilus oregonensis		2,057.31	Northern pikeminnow	Cyprinidae	2
6	*Hyallela azteca*	7.44	7.44	Amphipod	Hyalellidae	1, 2
5	*Thymallus arcticus*	4.79	4.79	Arctic grayling	Salmonidae	1
4	*Oncorhynchus kisutch*	3.46	5.68	Coho salmon	Salmonidae	1
	Oncorhynchus tshawytscha		3.95	Chinook salmon	Salmonidae	1
	Oncorhynchus mykiss		1.85	Rainbow trout	Salmonidae	1
3	*Morone saxatilis*	3.18	3.18	Striped bass	Percichthyidae	2
2	*Salmo trutta*	2.21	2.21	Brown trout	Salmonidae	1
1	*Salvelinus fontinalis*	1.91	<1.76	Brook trout	Salmonidae	1
	Salvelinus confluentus		2.08	Bull trout	Salmonidae	1

[1] Used in cold water calculations.
[2] Used in warm water calculations.
* Only the most sensitive species was used to calculate the GMAV .

CADMIUM CRITERIA RECALCULATION

Once the revised databases were compiled, the genera were ranked by their corresponding GMAVs/GMCVs (Stephan *et al.* 1985). The four most sensitive genera were then selected and a series of calculations were conducted using the GMAVs/GMCVs for these genera to determine the final acute value (FAV) and final chronic value (FCV). Factors that significantly influence these final values include the number of genera in the database, and the magnitude and spread of the GMAVs/GMCVs for the four most sensitive genera..

Acute Cadmium Hardness Relationship

When enough data are available to show that the toxicity of a substance is related to a water quality characteristic for two or more species, the relationship is accounted for using analyses of covariance (Stephan *et al.* 1985). This appears to be the case for the relationship between cadmium toxicity and water hardness. The 2001 Cadmium Update normalized data and used analysis of covariance (Stephen *et al.* 1985) to obtain the acute hardness slope. Definitive acute values were available for 12 species over a range of hardness values such that the highest hardness was at least three times the lowest, and the highest was also at least 100 mg/L higher than the lowest. Only acute tests initiated with individuals less than 24-hour old neonates were used to estimate the hardness slope for *D. magna*. The individual species slopes ranged from 0.1086 (*D. magna*) to 2.03 (*P. promelas*), and the pooled slope was 1.17. However, the U.S. EPA decided that there was too much variability associated with the slopes for *D. magna* and *P. promelas*. Therefore, only the Chapman *et al.* manuscript data were used to compute the slope for *D. magna* (1.18) and only adult data were used to compute the slope for *P. promelas* (1.22). When the adjusted data set was used, the resultant pooled slope was 1.0166. This value was used by U.S. EPA to adjust all acute values to a common hardness (50 mg/L) and is also included in the final acute equation.

Reviewing data used to calculate the acute hardness slope in the 2001 Cadmium Update and adding data from the revised CEC acute database allowed development of a revised CEC acute hardness relationship (Table 6). One major conflict with data selection for the 2001 Cadmium Update acute hardness relationship is U.S. EPA's decision to limit fathead minnow data to adults, when only the toxicity data of the more sensitive

TABLE 6: Updated acute cadmium hardness slope. SMAS = species mean acute slope.

Species	hardness (mg/L)	geomean (hardness)	normalized hardness	LC_{50}/EC_{50} (µg/L)	geomean (acute)	normalized acute	Reference	ln (norm hard)	ln (norm acute)	SMAS	R^2
Limnodrilus hoffmeisteri	5.3		0.19	170.00		0.27	Chapman *et al.* 1982	-1.678	-1.324		--
Limnodrilus hoffmeisteri	152.0	28.38	5.36	2,400.00	638.75	3.76	Williams *et al.* 1985	1.678	1.324	0.7888	--
Tubifex tubifex	128.0		2.89	3,200.00		2.66	Reynoldson *et al.* 1996	1.061	0.978		
Tubifex tubifex	128.0		2.89	1,700.00		1.41	Reynoldson *et al.* 1996	1.061	0.346		
Tubifex tubifex	5.3	44.28	0.12	320.00	1,202.96	0.27	Chapman *et al.* 1982	-2.123	-1.324	0.6238	0.93
Vilosa vibex	40.0		0.46	30.00		0.49	Keller as cited in U.S. EPA 2001	-0.768	-0.714		
Vilosa vibex	186.0	86.26	2.16	125.00	61.24	2.04	Keller as cited in U.S. EPA 2001	0.768	0.714	0.9286	--
Daphnia magna	51.0		0.43	9.90		0.31	Chapman *et al.* Manuscript	-0.839	-1.178		
Daphnia magna	104.0		0.88	33.00		1.03	Chapman *et al.* Manuscript	-0.127	0.026		
Daphnia magna	105.0		0.89	34.00		1.06	Chapman *et al.* Manuscript	-0.117	0.056		
Daphnia magna	197.0		1.67	63.00		1.96	Chapman *et al.* Manuscript	0.512	0.673		
Daphnia magna	209.0	118.05	1.77	49.00	32.14	1.52	Chapman *et al.* Manuscript	0.571	0.422	1.1824	0.91
Daphnia pulex	57.0		0.60	47.00		0.53	Bertram and Hart 1979	-0.508	-0.636		
Daphnia pulex	240.0		2.53	319.00		3.59	Elnabarawy *et al.* 1986	0.930	1.279		
Daphnia pulex	120.0		1.27	80.00		0.90	Hall *et al.* 1986	0.237	-0.104		
Daphnia pulex	120.0		1.27	100.00		1.13	Hall *et al.* 1986	0.237	0.119		
Daphnia pulex	53.5		0.56	70.10		0.79	Stackhouse and Benson 1988	-0.571	-0.236		
Daphnia pulex	85.0		0.90	66.00		0.74	Roux *et al.* 1993	-0.108	-0.296		
Daphnia pulex	85.0		0.90	99.00		1.12	Roux *et al.* 1993	-0.108	0.109		
Daphnia pulex	85.0	94.71	0.90	70.00	88.74	0.79	Roux *et al.* 1993	5.52	-0.237	1.0633	0.79
Oncorhynchus tshawytscha	211.0		4.05	26.00		5.27	Hamilton and Buhl 1990	1.398	1.661		
Oncorhynchus tshawytscha	343.0		6.58	57.00		11.55	Hamilton and Buhl 1990	1.884	2.446		
Oncorhynchus tshawytscha	23.0		0.44	1.80		0.36	Chapman 1975, 1978	-0.819	-1.009		
Oncorhynchus tshawytscha	23.0		0.44	3.50		0.71	Chapman 1975, 1978	-0.819	-0.344		

TABLE 6: Continued.

Species	hardness (mg/L)	geomean (hardness)	normalized hardness	LC_{50}/EC_{50} (µg/L)	geomean (acute)	normalized acute	Reference	ln (norm hard)	ln (norm acute)	SMAS	R^2
Lepomis cyanellus	360.0		3.00	66,000.00		4.55	Pickering and Henderson 1966	1.100	1.515		
Lepomis cyanellus	85.5		0.71	11,520.00		0.79	Carrier and Beitinger 1988b	-0.338	-0.230		
Lepomis cyanellus	335.0	119.84	2.80	20,500.00	14,504.98	1.41	Jude 1973	1.028	0.346	0.8986	0.88
Lepomis macrochirus	20.0		0.56	1,940.00		0.46	Pickering and Henderson 1966	-0.585	-0.786		
Lepomis macrochirus	18.0		0.50	2,300.00		0.54	Bishop and McIntosh 1981	-0.690	-0.616		
Lepomis macrochirus	18.0		0.50	2,300.00		0.54	Bishop and McIntosh 1981	-0.690	-0.616		
Lepomis macrochirus	207.0		5.77	21,100.00		4.95	Eaton 1980	1.752	1.600		
Lepomis macrochirus	44.4	35.89	1.24	6,470.00	4,258.80	1.52	Phipps and Holcombe 1985	0.213	0.418	0.9531	0.95
Oncorhynchus mykiss	420.0		6.93	7.40		4.04	Davies *et al.* 1993	1.935	1.397		
Oncorhynchus mykiss	427.0		7.04	5.92		3.23	Davies *et al.* 1993	1.952	1.174		
Oncorhynchus mykiss	217.0		3.58	4.20		2.29	Davies *et al.* 1993	1.275	0.830		
Oncorhynchus mykiss	227.0		3.74	6.57		3.59	Davies *et al.* 1993	1.320	1.278		
Oncorhynchus mykiss	46.0		0.76	2.64		1.44	Davies *et al.* 1993	-0.276	0.366		
Oncorhynchus mykiss	49.0		0.81	3.08		1.68	Davies *et al.* 1993	-0.213	0.520		
Oncorhynchus mykiss	23.0		0.38	1.30		0.71	Chapman 1975; 1978	-0.969	-0.342		
Oncorhynchus mykiss	23.0		0.38	1.00		0.55	Chapman 1978	-0.969	-0.605		
Oncorhynchus mykiss	31.0		0.51	1.75		0.96	Davies 1976	-0.671	-0.045		
Oncorhynchus mykiss	44.4		0.73	3.00		1.64	Phipps and Holcombe 1985	-0.312	0.494		
Oncorhynchus mykiss	30.7		0.51	0.71		0.39	Stratus Consulting 1999	-0.681	-0.947		
Oncorhynchus mykiss	29.3		0.48	0.47		0.26	Stratus Consulting 1999	-0.727	-1.360		
Oncorhynchus mykiss	31.7		0.52	0.51		0.28	Stratus Consulting 1999	-0.649	-1.278		
Oncorhynchus mykiss	30.2		0.50	0.38		0.21	Stratus Consulting 1999	-0.697	-1.572		
Oncorhynchus mykiss	30.0		0.49	1.29		0.70	Stratus Consulting 1999	-0.704	-0.350		
Oncorhynchus mykiss	89.3	60.64	1.47	2.85	1.83	1.56	Stratus Consulting 1999	0.387	0.442	0.7679	0.68
									Revised pooled acute slope =	**0.9059**	**0.69**

yet lower than all other SMAVs in the 2001 Cadmium Update database. Following this approach, we lowered the revised FAV to the lowest GMAV (*Salvelinus*) of 1.910 µg/L to again further protect trout (Table 4). At a hardness of 100 mg/L, the revised CMC is 2.704 µg/L using the entire database or 1.790 µg/L using the lowered "trout" FAV

Chronic Hardness Relationship

The 2001 Cadmium Update also used the same procedures as the acute slope to obtain a slope that defines the chronic hardness relationship. The chronic hardness relationship was derived from three species, *D. magna, S. trutta,* and *P. promelas*. The individual species slopes ranged form 0.5212 (*S. trutta*) to 1.579 (*D. magna*), and the pooled slope was 0.9685. However, as with the acute slope, the *D. magna* data was determined too variable and, therefore, only data from the Chapman *et al.* manuscript was used. The resultant pooled slope with the reduced data set was 0.7409.

The revised CEC chronic hardness relationship was derived by reviewing data used to calculate the chronic hardness slope calculation in the 2001 Cadmium Update and adding data from the CEC revised chronic database (Table 8). The revised pooled chronic slope was derived from 9 individual data points that encompasses three species. Individual species slopes ranged from 0.4779 (*O. mykiss*) to 1.0034 (*P. promelas*). Since Chapman *et al.* manuscript data for *D. magna* were deleted from the revised chronic database, we also deleted these data from the chronic hardness slope database. This removes all *D. magna* data used in the final slope presented by the EPA and, therefore, removes *D. magna* from the chronic hardness slope calculation. However, the Davies *et al.* (1993) chronic toxicity tests for *O. mykiss* increased the range of hardness values tested. Target values ranged from 50 mg/L to 400 mg/L, enabling us to add this previously unused species to the chronic hardness slope database. Finally, the Davies and Brinkman (1994) data point for *S. trutta* was added to the database. Analysis of covariance determined the individual species slopes of the revised chronic slope database are not different ($p = 0.66$). Therefore, all data were grouped and the pooled slope of this revised database is 0.7635. This slope was used to standardize all chronic toxicity values to a common hardness and is in the final equation to compute the chronic AWQC at a given hardness.

Chronic Calculations

The recalculated FCV was then determined using the GMCVs for the four most sensitive genera in the revised chronic database. Calculations followed the U.S. EPA methods for criteria derivation (Stephan *et al.* 1985) and are presented in Table 9. The recalculated FCV is 0.295 µg/L, whereas the FCV from the 2001 Cadmium Update was 0.162 µg/L. This results in a final chronic equation of $e^{0.7635\,[\ln(\text{hardness})]-4.2062}$ for cadmium. At a hardness of 100 mg/L, the revised chronic cadmium criteria based upon this equation is 0.502 µg/L. These calculations indicate that the revised chronic criteria (0.502 µg/L at a hardness of 100 mg/L) is roughly twice the criteria based on the 2001 cadmium document (0.271 µg/L at a hardness of 100 mg/L).

TABLE 9: Recalculation of the final chronic values for cadmium using the updated chronic database (N = 16 genera, R = sensitivity rank in database, P = rank / N+1).

Rank	Genus	GMCV	ln GMCV	(ln GMCV)^2	P = R/(N+1)	√P
4	*Chironomus*	2.697	0.9922	0.9845	0.2353	0.4851
3	*Oncorhynchus*	2.345	0.8523	0.7263	0.1765	0.4201
2	*Daphnia*	1.994	0.6903	0.4765	0.1176	0.343
1	*Hyalella*	0.276	-1.2861	1.6540	0.0588	0.2425
		sum	1.2487	3.8414	0.5882	1.4907

Calculations:
Chronic Criterion

$$S^2 = \frac{\Sigma(\ln GMCV)^2 - (\Sigma \ln GMCV)^2/4}{\Sigma P - (\Sigma\sqrt{P})^2/4} = \frac{3.8414 - (1.2487)^2/4}{0.5882 - (1.4907)^2/4} = 105.5595 \qquad S = 10.2742$$

$L = [\Sigma \ln GMCV - S(\Sigma\sqrt{P})]/4 = [1.2487 - 10.2742\,(1.4907)]/4 = -3.5167$
$A = S\,(\sqrt{0.05}) + L = (10.2742)(0.2236) + -3.5167 = -1.2194$
Final Chronic Value = FCV = e^A = 0.295
Pooled Slope = 0.7635

ln (Final Chronic Intercept) = ln FCV - [chronic slope × ln(standardized hardness level)]
= ln (0.295) - [0.7635 × ln (50)]
= -4.2062

Recalculated Chronic Cadmium Criterion = $e^{0.7635\,[\ln(\text{hardness})]-4.2062}$ @ Hardness 100 = 0.502 µg/L

TABLE 10: Cadmium acute-chronic ratio. Only **bold** values were used in the final calculation.

Species	Reference	Hardness	Acute Value	Chronic Value	Ratio	SMAV	SMACR
Jordanella floridae	Spehar 1976	44.0	2,500.00	5.76	433.80	2,814.67	433.8018
Lepomis macrochirus	Eaton 1974	207.0	21,100.00	49.80	423.70	6,388.68	423.6948
Aplexa hypnorum	Holcombe *et al.* 1984	45.3	93.00	5.80	16.03	102.87	20.7584
Aplexa hypnorum	Holcombe *et al.* 1984	45.3	93.00	3.46	26.88		
Ceriodaphnia dubia	Suedel *et al.* 1997	17.0	63.10	2.00	31.55	49.77	31.5500
Pimephales promelas	Pickering and Gast 1972	201.0	5,995.00	45.92	130.55	28.35	**13.1275**
Pimephales promelas	Spehar and Fiandt 1986	44.0	13.20	10.00	1.32		
Daphnia magna	Canton and Sloof 1982	209.2	30.00	0.67	44.78	15.49	44.7751
Oncorhynchus tshawytscha	Chapman 1975, 1982	25.0	1.41	1.56	0.90	4.02	**0.9021**
*Oncorhynchus mykiss**	Davies *et al.* 1993	400.0	7.40	3.64	2.03	1.86	**1.7298**
*Oncorhynchus mykiss**	Davies *et al.* 1993	400.0	5.92	3.64	1.63		
*Oncorhynchus mykiss**	Davies *et al.* 1993	200.0	4.20	3.58	1.17		
*Oncorhynchus mykiss**	Davies *et al.* 1993	200.0	6.57	3.58	1.84		
*Oncorhynchus mykiss**	Davies *et al.* 1993	50.0	2.64	1.47	1.80		
*Oncorhynchus mykiss**	Davies *et al.* 1993	50.0	3.08	1.47	2.10		
				Final acute-chronic ratio =			**2.7362**

* Acute values were grouped with chronic values of like target hardness values.

USE-SPECIFIC CADMIUM CRITERIA

AWQC are based on protection of all species, as is appropriate for nationally based criteria. Such broad criteria may contain species not resident in particular water bodies. This discrepancy is generally addressed through the use of site-specific criteria. However, it is possible to address this concern through "use-specific" criteria.

As such, cadmium AWQC were also derived specific to warm and cold freshwater use classifications. These calculations were designed to include all species in the cadmium acute and chronic databases that could potentially occur in each of these use classifications. However, the minimum data requirements for the development of national AWQC are not met by these revised data sets, specifically the "eight-family rule" is not met for either database. For example, warmwater use-specific standards do not include the family Salmonidae, a requirement of the "eight-family rule," because salmonids do not occur in warmwater.

TABLE 11: Recalculation of the final acute values for cadmium using the revised warmwater acute database (N = 52 genera, R = sensitivity rank in database, P = rank / N+1).

Rank	Genus	GMAV	ln GMAV	(ln GMAV)^2	P = R/(N+1)	√P
4	*Simocephalus*	27.580	3.3171	11.0031	0.0755	0.2747
3	*Ptychocheilus*	26.262	3.2681	10.6806	0.0566	0.2379
2	*Hyallela*	7.440	2.0069	4.0277	0.0377	0.1943
1	*Morone*	3.181	1.1572	1.3390	0.0189	0.1374
		sum	9.7493	27.0504	0.1887	0.8443

Calculations:

Acute Criterion

$S^2 = \frac{\Sigma(\ln GMAV)^2 - (\Sigma \ln GMAV)^2/4}{\Sigma P - (\Sigma\sqrt{P})^2/4} = \frac{27.0504 - (9.7493)^2/4}{0.1887 - (0.8443)^2/4} = 313.5296$ S = 17.7068

$L = [\Sigma \ln GMAV - S(\Sigma\sqrt{P})]/4 = [9.7493 - 17.7068\,(0.8443)]/4 = 1.2999$
$A = S\,(\sqrt{0.05}) + L = (17.7068)(0.2236) - 1.2999 = 2.6594$

Final Acute Value = FAV = e^A = 14.2880
CMC = ½ FAV = 7.1440
Pooled Slope = 0.9059

ln (Criterion Maximum Intercept)
= lnCMC - [pooled slope × ln (standardized hardness level)]
= ln (7.1440) - [0.9059 × ln (50)]
= -1.5776

Warmwater Acute Cadmium Criterion = $e^{0.9059\,[\ln(\text{hardness})]\,-1.5776}$
@ Hardness 100 = 13.386 µg/L

Lowered to protect striped bass
FAV = 3.1809
CMC = 1.5905

= ln(1.5905)-[0.9059×ln(50)]
= -3.0799

Criterion to protect striped bass = $e^{0.9059[\ln(\text{hardness})]-3.0799}$
@ Hardness 100 = 2.980 µg/L

Chronic Criterion
Chronic Slope = 0.7635 (recalculated)
Final Acute-to-Chronic ratio (FACR) = 2.7632 (recalculated)

Final Chronic Value (FCV) = FAV ÷ ACR = 14.288 ÷ 2.7632 = 5.171 = 3.181 ÷ 2.7632 = 1.151

ln (Final Chronic Intercept) = ln FCV - [chronic slope × ln(standardized hardness level)]
= ln (5.171) - [0.7635 × ln (50)]
= -1.3438

= ln(1.151)-[0.7635×ln(50)]
= -2.8461

Coldwater Chronic Cadmium Criterion = $e^{0.7635\,[\ln(\text{hardness})]\,-1.3975}$
@ Hardness 100 = 8.778 µg/L

Criterion to protect striped bass = $e^{0.7635[\ln(\text{hardness})]-2.8461}$
@ Hardness 100 = 1.954 µg/L

TABLE 12: Recalculation of the final acute values for cadmium using the revised coldwater acute database (N = 42 genera, R = sensitivity rank in database, P = rank / N+1).

Rank	Genus	GMAV	ln GMAV	(ln GMAV)^2	P = R/(N+1)	√P
4	*Thymallus*	4.788	1.5661	2.4526	0.0930	0.3050
3	*Oncorhynchus*	3.460	1.2412	1.5406	0.0698	0.2641
2	*Salmo*	2.207	0.7919	0.6270	0.0465	0.2157
1	*Salvelinus*	1.910	0.6472	0.4189	0.0233	0.1525
		sum	4.2464	5.0392	0.2326	0.9373

Calculations:

Acute Criterion

$S^2 = \dfrac{\Sigma(\ln GMAV)^2 - (\Sigma \ln GMAV)^2/4}{\Sigma P - (\Sigma\sqrt{P})^2/4} = \dfrac{5.0392 - (4.2464)^2/4}{0.2326 - (0.9373)^2/4} = 41.0945$ S = 6.4105

L = [ΣlnGMAV - S(Σ√P)]/4 = [4.2464 - 6.4105 (0.9373)]/4 = -0.4405

A = S (√0.05) + L = (6.4105)(0.2236) + -0.4405 = 0.9929

Final Acute Value = FAV = e^A = 2.6990

CMC = ½ FAV = 1.3495

Pooled Slope = 0.9059

Lowered to protect trout

FAV = 1.9102

CMC = 0.9551

ln (Criterion Maximum Intercept) = lnCMC - [pooled slope × ln (standardized hardness level)]

= ln (1.3495) - [0.9059 × ln (50)]

= -3.2442

= ln(0.955)-[0.9059×ln(50)]

= - 3.5898

Coldwater Acute Cadmium Criterion = $e^{0.9059[\ln(\text{hardness})]-3.2442}$

@ Hardness 100 = 2.529 µg/L

Criterion to protect trout = $e^{0.9059[\ln(\text{hardness})]-3.5898}$

@ Hardness 100 = 1.790 µg/L

Chronic Criterion

Chronic Slope = 0.7635 (recalculated)

Final Acute-to-Chronic ratio (FACR) = 2.7632 (recalculated)

Final Chronic Value (FCV) = FAV ÷ ACR = 2.6990 ÷ 2.7632 = 0.977 = 1.910 ÷ 2.7632 = 0.691

ln (Final Chronic Intercept) = ln FCV - [chronic slope × ln(standardized hardness level)]

= ln (0.977) - [0.7635 × ln (50)]

= -3.0103

= ln(0.691)-[0.7635×ln(50)]

= -3.3560

Coldwater Chronic Cadmium Criterion = $e^{0.7635[\ln(\text{hardness})]-3.0103}$

@ Hardness 100 = 1.658 µg/L

Criterion to protect trout = $e^{0.7635[\ln(\text{hardness})]-3.3560}$

@ Hardness 100 = 1.174 µg/L

TABLE 13: Summary of criterion maximum concentration (CMC) and criterion continuous concentration (CCC) at various hardness values for cadmium. All values are reported in µg/L.

	Hardness (mg/L)									
	25	50	75	100	150	200	250	300	350	400
2001 EPA Update										
CMC = $e^{1.0166[\ln(\text{hardness})]-3.924}$	0.521	1.054	1.592	2.133	3.221	4.316	5.415	6.517	7.623	8.731
CMC = $e^{0.7409[\ln(\text{hardness})]-4.719}$	0.097	0.162	0.271	0.365	0.452	0.534	0.611	0.611	0.658	0.756
CEC Revision (all data)										
CMC = $e^{0.9059[\ln(\text{hardness})]-3.1772}$	0.770	1.443	2.083	2.704	3.904	5.066	6.201	7.314	8.411	9.492
CMC^{a} = $e^{0.9059[\ln(\text{hardness})]-3.5898}$	0.510	0.955	1.379	1.790	2.584	3.353	4.105	4.842	5.567	6.283
CCC = $e^{0.7635[\ln(\text{hardness})]-4.2062}$	0.174	0.295	0.403	0.501	0.683	0.851	1.009	1.160	1.305	1.445
CCC^{b} = $e^{0.7635[\ln(\text{hardness})]-2.9434}$	0.615	1.044	1.423	1.773	2.416	3.010	3.569	4.102	4.614	5.109
CCC^{ab} = $e^{0.7635[\ln(\text{hardness})]-3.3560}$	0.407	0.691	0.942	1.174	1.599	1.992	2.362	2.715	3.054	3.382
CEC Revision (coldwater)										
CMC = $e^{0.9059[\ln(\text{hardness})]-3.2442}$	0.720	1.349	1.948	2.528	3.651	4.738	5.799	6.840	7.866	8.877
CCC^{b} = $e^{0.7635[\ln(\text{hardness})]-3.0103}$	0.575	0.977	1.331	1.658	2.260	2.815	3.338	3.836	4.316	4.779
CEC Revision (warmwater)										
CMC = $e^{0.9059[\ln(\text{hardness})]-1.5776}$	3.813	7.144	10.315	13.386	19.328	25.082	30.701	36.214	41.642	46.996
CMC^{a} = $e^{0.9059[\ln(\text{harndess})]-3.0799}$	0.849	1.590	2.296	2.980	4.303	5.584	6.835	8.062	9.270	10.462
CCC = $e^{0.7635[\ln(\text{hardness})]-4.5126}$	0.128	0.217	0.296	0.369	0.503	0.627	0.743	0.854	0.961	1.064
CCC^{b} = $e^{0.7635[\ln(\text{hardness})]-1.3438}$	3.046	5.171	7.047	8.778	11.963	14.902	17.669	20.308	22.845	25.297
CCC^{ab} = $e^{0.7635[\ln(\text{hardness})]-2.8461}$	0.678	1.151	1.569	1.954	2.663	3.317	3.934	4.521	5.086	5.632

Data Limitations and Caveats to Cadmium Criteria

The CEC revised FAVs and FCVs were derived from the best database presently available. Unfortunately, much of the data available for cadmium is limited, variable, and often dated. Additional testing of the acute and chronic cadmium toxicities for various key species is necessary to decrease data variability and more accurately define the toxicity of cadmium to sensitive species. For example, *Salvelinus* is the most sensitive genus in the acute database for cadmium. And yet, the acute value reported for one of the two species in this genus is based on an undefined value and, according to an unused data point (Holcombe *et al.* 1983), can vary by more than a factor of 5,000! Furthermore, *Salmo* is the second most sensitive genus in the acute database for cadmium, and is based on only 2 data points from two studies. Neither of these studies were conducted using the preferred flow-through methodology. Additional testing should be conducted to determine

LITERATURE CITED

Attar, E.N., and E.J. Maly. 1982. Acute toxicity of cadmium, zinc, and cadmium-zinc mixtures to *Daphnia magna*. *Archives of Environmental Contamination and Toxicology* 11: 291-296.

Bertram, P.E., and B.A. Hart. 1979. Longevity and reproduction of *Daphnia pulex* (deGeer) exposed to cadmium-contaminated food and water. *Environmental Pollution* 19:295.

Bishop, W.E., and A.W. McIntosh. 1981. Acute lethality and effects of sublethal cadmium exposure on ventilation frequency and cough rate of bluegill (*Lepomis macrochirus*). *Archives of Environmental Contamination and Toxicology* 10:519.

Bodar, C.W.M., C.J. Van Leeuwen, P.A. Voogt, and D.I. Zandee. 1988. Effect of cadmium on the reproduction strategy of *Daphnia magna*. *Aquatic Toxicology* 12:301-310.

Brown, V., D. Shurben, W. Miller, and M. Crane. 1994. Cadmium toxicity to rainbow trout *Oncorhynchus mykiss* Walbaum and brown trout *Salmo trutta* L. over extended exposure periods. *Ecotoxicology and Environmental Safety* 29:38-46.

Buhl, K.J., and S.J. Hamilton. 1991. Relative sensitivity of early life stages of arctic grayling, coho salmon, and rainbow trout to nine inorganics. *Ecotoxicology and Environmental Safety* 22:184-197.

Canton, J.H., and W. Slooff. 1982. Toxicity and accumulation studies of cadmium (Cd^{2+}) with freshwater organisms of different trophic levels. *Ecotoxicology and Environmental Safety* 6:113-128.

Carrier, R., and T.L. Beitinger. 1988a. Reduction in thermal tolerance of *Notropis lutrensis* and *Pimephales promelas* exposed to cadmium. *Water Research* 22(4):511-515.

Carrier, R., and T.L. Beitinger. 1988b. Resistance of temperature tolerance ability of green sunfish to cadmium exposure. *Bulletin of Environmental Contamination and Toxicology* 40:475-480.

Carroll, J.J., S.J. Ellis, and W.S. Olvier. 1979. Influences of hardness constituents on the acute toxicity of cadmium to brook trout (*Salvelinus fontinalis*). *Bulletin of Environmental Contamination and Toxicology* 22: 575-581.

Chadwick Ecological Consultants, Inc. 2003. *Chronic Toxicity of Cadmium to Freshwater Crustaceans at Different Water Hardness Concentrations*. Report prepared for Thompson Creek Mining Company, Challis, ID.

Chapman, G.A. 1975. *Toxicity of Copper, Cadmium, and Zinc to Pacific Northwest Salmoides*. U.S. Environmental Protection Agency, Corvallis, OR.

Chapman, G.A. 1978. Toxicities of cadmium, copper, and zinc to four juvenile stages of chinook salmon and steelhead. *Transactions of the American Fisheries Society* 107:841.

Holcombe, G.W., G.L. Phipps, and J.W. Marier. 1984. Methods for conducting snail (*Aplex hypnorum*) embryo through adult exposures: Effects of cadmium and reduced pH levels. *Archives of Environmental Contamination and Toxicology* 13:627.

Hughes, J.S. 1973. Acute toxicity of thirty chemicals to striped bass (*Morone saxatilis*). *Western Association of State Game and Fish Commission*, Salt Lake City, UT.

Ingersoll, C., and N. Kemble. 2001. Internal document, U.S. Department of the Interior.

Jude, D.J. 1973. *Sublethal Effects of Ammonia and Cadmium on Growth of Green Sunfish*. Ph.D. Thesis, Michigan State University.

Keller, A.E. 2001. Personal communication to U.S. EPA, as cited in *2001 Update of Ambient Water Quality Criteria for Cadmium*. EPA-822-R-01-001. Office of Water, Washington, DC.

McCarty, L.S., J.A.C Henry, and A.H. Houston. 1978. Toxicity of cadmium to goldfish, *Carassius auratus*, in hard and soft water. *Journal of the Fisheries Research Board of Canada* 35:35.

Palawski, D., J.B. Hunn, and F.J. Dwyer. 1985. Sensitivity of young striped bass to organic and inorganic contaminants in fresh and saline water. *Transactions of the American Fisheries Society* 114:748-753.

Phipps, G.L., and G.W. Holcombe. 1985. A method for aquatic multiple species toxicant testing: acute toxicity of 10 chemicals to 5 vertebrates and 2 invertebrates. *Environmental Pollution* (Series A) 38:141-157.

Pickering, Q.H., and C. Henderson. 1966. The acute toxicity of some heavy metals to different species of warmwater fishes. *Air and Water Pollution International Journal* 10:453.

Pickering, Q.H., and M.H. Gast. 1972. Acute and chronic toxicity of cadmium to the fathead minnow (*Pimephales promelas*). *Journal of the Fisheries Research Board of Canada* 29:1099.

Reynoldson, T.B., P. Rodriquez, and M.M. Madrid. 1996. A comparison of reproduction, growth and acute toxicity in two populations of *Tubifex tubifex* (Muller, 1774) from the North American great lakes and Northern Spain. *Hydrobiologia* 334:199-206.

Rifici, L.M., D.S. Cherry, J.L. Farris, and J. Cairns, Jr. 1996. Acute and subchronic toxicity of methyleneblue to larval fathead minnows (*Pimephales promelas*): implications for aquatic toxicity testing. *Environmental Toxicology and Chemistry* 15(8):1304-1308.

Roux, D.J., P.L. Kempster, E. Truter, and L. Van der Merwe. 1993. Effect of cadmium and copper onsurvival and reproduction of *Daphnia pulex*. *Water SA* 19(4):269-274.

Schubauer-Berigan, M.K., J.R. Diekes, P.D. Monson, and G.T. Ankley. 1993. pH-dependent toxicity of Cd, Cu, Ni, Pb, and Zn to *Ceriodaphnia dubia*, *Pimephales promelas*, *Hyalella azteca*, and *Lumbriculus variegatus*. *Environmental Toxicology and Chemistry* 12:1261-1266.

APPENDIX A

Ranked Use-Specific Toxicity Databases

TABLE A-1: Continued.

Rank	Species	GMAV	SMAV	Common Name	Family
19	*Physa gyrina*	116.78	116.78	Snail	Physidae
18	*Aplexa hypnorum*	102.63	102.63	Snail	Physidae
17	*Gammarus pseudolimnaeus*	77.48	77.48	Amphipod	Gammaridae
16	*Lirceus amabamae*	54.78	54.78	Isopod	Asellidae
15	*Ceriodaphnia dubia*	48.45	49.92	Cladoceran	Daphnidae
	Ceriodaphnia reticulata		47.02	Cladoceran	Daphnidae
14	*Moina macrocopa*	45.52	45.52	Cladoceran	Daphnidae
13	*Gila elegans*	45.12	45.12	Bonytail	Cyprinidae
12	*Utterbackia imbecilis*	45.08	45.08	Mussel	Unionidae
11	*Xyrauchen texanus*	42.67	42.67	Razorback sucker	Castostomidae
10	*Lophopodella carteri*	41.78	41.78	Bryozoan	Lophopodidae
9	*Vilosa vibex*	37.37	37.37	Mussel	Unionidae
8	*Actinonaia pectorosa*	35.75	35.75	Mussel	Unionidae
7	*Lampsilis straminea claibornensis*	32.94	46.51	Mussel	Unionidae
	Lampsilis teres		23.32	Mussel	Unionidae
6	*Pimephales promelas*	28.52	28.52	Fathead minnow	Cyprinidae
5	*Daphnia pulex*	27.62	49.26	Cladoceran	Daphnidae
	Daphnia magna		15.49	Cladoceran	Daphnidae
4	*Simocephalus serrulatus*	27.58	27.58	Cladoceran	Daphnidae
3	*Ptychocheilus lucius*	26.26*	26.26	Colorado pikeminnow	Cyprinidae
	Ptychocheilus oregonensis		2057.31	Northern pikeminnow	Cyprinidae
2	*Hyallela azteca*	7.44	7.44	Amphipod	Hyalellidae
1	*Morone saxatilis*	3.18	3.18	Striped bass	Perichthyidae

* Only the most sensitive species was used to calculate the GMAV.

TABLE A-3: Coldwater acute species list.

Rank	Species	GMAV	SMAV	Common Name	Family
42	*Chironomus riparius*	19,256.25	109,568.59	Midge	Chironomidae
	Chironomus tentans		7,854.85	Midge	Chironomidae
	Chironomus plumosus		8,296.43	Midge	Chironomidae
41	*Dendrocoelum lacteum*	14,956.11	14,956.11	Planaria	Dendrocoelidae
40	*Orconectes virilis*	>11,193.54	11,030.68	Crayfish	Astacidae
	Orconectes immunis		>11,358.81	Crayfish	Astacidae
39	*Rhyacodrilus montana*	4,811.89	4,811.89	Tubificid worm	Tubificidae
38	*Stylodrilus heringianus*	4,200.86	4,200.86	Tubificid worm	Tubificidae
37	*Spirosperma ferox*	3,031.21	2,673.27	Tubificid worm	Tubificidae
	Spirosperma nikolskyi		3,437.07	Tubificid worm	Tubificidae
36	*Varichaeta pacifica*	2,902.41	2,902.41	Tubificid worm	Tubificidae
35	*Jordanella floridae*	2,806.94	2,806.94	Flagfish	Cyprinodontidae
34	*Catostomus commersoni*	2,800.71	2,800.71	White sucker	Castostomidae
33	*Quistradilus multisetosus*	2,444.14	2,444.14	Tubificid worm	Tubificidae
32	*Ephemerella grandis*	2,245.55	2,245.55	Mayfly	Ephemerillidae
31	*Branchiura sowerbyi*	1,833.10	1,833.10	Tubificid worm	Tubificidae
30	*Crangonyx pseudogracilis*	1,700.00	1,700.00	Amphipod	Cragonyctidae
29	*Procambarus clarkii*	1,651.99	1,651.99	Crayfish	Cambaridae
28	*Tubifex tubifex*	1,342.84	1,342.84	Tubificid worm	Tubificidae
27	*Limnodrilus hoffmeisteri*	876.55	876.55	Tubificid worm	Tubificidae
26	*Asellus bicrenata*	556.25	556.25	Isopod	Asellidae
25	*Ambystoma gracile*	515.31	515.31	Salamander	Salmonidae
24	*Plumatella emarginata*	303.60	303.60	Bryozoan	Plumatellidae
23	*Alona affinis*	269.52	269.52	Cladoceran	Chydoridae
22	*Cyclops varicans*	243.35	243.35	Copepod	Cyclopidae
21	*Glossiponia complanta*	212.68	212.68	Leech	Glossiphoniidae
20	*Pectinatella magnifica*	194.97	194.97	Bryozoan	Pectinatelidae
19	*Lumbriculus variegatus*	158.67	158.67	Worm	Lumbriculidae
18	*Physa gyrina*	116.78	116.78	Snail	Physidae
17	*Aplexa hypnorum*	102.63	102.63	Snail	Physidae
16	*Gammarus pseudolimnaeus*	77.48	77.48	Amphipod	Gammaridae
15	*Lirceus amabamae*	54.78	54.78	Isopod	Asellidae
14	*Ceriodaphnia dubia*	48.45	49.92	Cladoceran	Daphnidae
	Ceriodaphnia reticulata		47.02	Cladoceran	Daphnidae
13	*Moina macrocopa*	45.52	45.52	Cladoceran	Daphnidae
12	*Utterbackia imbecilis*	45.08	45.08	Mussel	Unionidae
11	*Lophopodella carteri*	41.78	41.78	Bryozoan	Lophopodidae
10	*Vilosa vibex*	37.37	37.37	Mussel	Unionidae

TABLE A-4: Coldwater chronic species list.

Rank	Species	GMCV	SMCV	Common Name	Family
11	*Aeolosoma headleyi*	20.62	20.62	Oligochaete	Aeolosomatidae
10	*Ceriodaphnia dubia*	11.24	11.24	Cladoceran	Daphnidae
9	*Esox lucins*	8.12	8.12	Northern pike	Esocidae
8	*Catostomus commersoni*	7.83	7.83	White sucker	Castostomidae
7	*Aplexa hypnorum*	4.83	4.83	Snail	Physidae
6	*Salmo salar*	4.72	8.06	Atlantic salmon	Salmonidae
	Salmo trutta		2.76	brown trout	Salmonidae
5	*Salvelinus fontinalis*	4.64	2.65	Brook trout	Salmonidae
	Salvelinus namaycush		8.11	Lake trout	Salmonidae
4	*Chironomus tentans*	2.70	2.70	Midge	Chironomidae
3	*Oncorhynchus kisutch*	2.34	4.28	Coho salmon	Salmonidae
	Oncorhynchus mykiss		1.14	Rainbow trout	Salmonidae
	Oncorhynchus tshawytscha		2.65	Chinook salmon	Salmonidae
2	*Daphnia magna*	1.99	1.11	Cladoceran	Daphnidae
	Daphnia pulex		3.59	Cladoceran	Daphnidae
1	*Hyalella azteca*	0.28	0.28	Amphipod	Hyalellidae

Chadwick Ecological Consultants, Inc.
5575 South Sycamore Street, Suite 101, Littleton, Colorado 80120
☎ (303) 794-5530, Fax: (303) 794-5041, e-mail: Chadeco@aol.com

DRAFT

December 2004

ADDENDUM TO *U.S. EPA CADMIUM WATER QUALITY CRITERIA DOCUMENT – TECHNICAL REVIEW AND CRITERIA UPDATE*

Introduction

The U.S. Environmental Protection Agency (U.S. EPA) revised its aquatic life criteria for cadmium on April 12, 2001, with the publication entitled *2001 Update of Ambient Water Quality Criteria for Cadmium* (U.S. EPA 2001). Chadwick Ecological Consultants, Inc. (CEC) conducted a technical review of the freshwater cadmium AWQC (CEC 2004) on behalf of the Association of Metropolitan Sewerage Agencies (AMSA).

This report included a technical review of the existing U.S. EPA 2001Cadmium Update, an extensive literature search to critically review available cadmium toxicity data in addition to those used in the derivation of the 2001 Cadmium Update, incorporation of new data not cited or available to U.S. EPA, and recalculation of updated acute and chronic cadmium criteria based on this analysis. This analysis culminated in a report entitled *U.S. EPA Cadmium Water Quality Criteria Document - Technical Review and Criteria Update* (CEC 2004) submitted to AMSA in September 2004. The results of this review were also presented to the Basic Standards Workgroup in September 2004. Since this presentation, we have received comments from the U.S. EPA, as well as comments and new data from the Colorado Division of Wildlife (CDOW). As a result of these comments and inclusion of the new data, our proposed acute and chronic criteria have changed slightly. These responses and the effect on criteria are summarized below.

Summary of Revision

Following response to the comments provided, there are slight changes to the acute and chronic hardness-based equations presented in our earlier report. These changes are summarized in the revised Table 13 from CEC 2004, presented below. Based on these changes, the general acute and chronic total cadmium equations are now as follows:

$$\text{Acute Cadmium} = e^{0.9151[(\text{hardness})]-3.6236}$$

$$\text{Chronic Cadmium} = e^{0.7998[(\text{hardness})]-4.4451}$$

acute value (FAV) by altering the acute hardness slope and genus mean acute value for *Salmo* (2nd most sensitive genus).

The CDOW also noted the availability of an additional data point (hardness = 39.8, LC_{50} = 1.87) generated by Davies and Brinkman (1994). We were aware of this data point when conducting the original literature review and determined acute data from this study were not suitable for use since data were generated from the first four days of a chronic test in which the organisms were fed. Test organisms are not generally fed during acute tests (Stephan *et al.* 1985). We had, however, found other useful acute data from another study ("Toxicity of Cadmium and Zinc to Wild Brown Trout") within the same publication (Davies and Brinkman 1994) that was already included in our updated database and listed in Table 2 of the original document (CEC 2004).

In comments from U.S. EPA, they reiterated their recommendations from the criteria document that chronic *Daphnia magna* data from an unpublished study by Chapman *et al.* be used in the calculations. The Chapman *et al.* manuscript chronic data for *D. magna* were eliminated from the updated chronic cadmium database in our original analysis (CEC 2004), not solely due to dissimilar values when compared to the remainder of the *Daphnia* data, but also due to insufficient information pertaining to chronic value calculations. Even though the Chapman *et al.* manuscript values remain substantially different and the results from additional testing concur with the other data presented for *D. magna*, we will add these data back into the database following U.S. EPA recommendations, as long as all other *Daphnia* data (including the recently added data for *D. magna* and data for *D. pulex*) are also included in the SMAV and GMAV calculations. We believe this is a reasonable solution for a genus with such highly divergent chronic values.

The addition of new acute data for *S. trutta* and re-inclusion of the chronic Chapman *et al.* data for *D. magna* results in a slightly steeper acute and chronic hardness slopes, respectively. The new data also increases the range of hardness concentrations tested for each organism such that *S. trutta* can be included in the acute hardness slope calculations and *D. magna* is re-included in the chronic hardness slope calculations. The new recalculated acute hardness slope of 0.9151 replaces the "updated slope" of 0.9059 presented by CEC (2004). Only the Chapman *et al.* manuscript and Canton and Sloof (1982) data are incorporated in the revised final pooled chronic slope of 0.7998, which replaces the "updated slope" of 0.7635 presented by CEC (2004). The revised ranked acute and chronic genus lists (Revised Tables 4 and 5) and the updated acute and chronic hardness slope calculation tables (Revised Tables 6 and 8 from CEC 2004) are as follows.

Revised Table 4 from CEC 2004 report entitled "U.S. EPA Cadmium Water Quality Criteria Document–Technical Review and Criteria Update" prepared for AMSA.

TABLE 4 - Revised: Revised acute cadmium criteria database (*revised 2004 following inclusion of new data from Brinkman and Hansen 2004*).

Rank	Species	GMAV (µg/L)	SMAV (µg/L)	Common Name	Family	Code
56	*Chironomus riparius*	19,256.57	108,453.52	Midge	Chironomidae	1, 2
	Chironomus tentans		7,933.19	Midge	Chironomidae	1, 2
	Chironomus plumosus		8,260.64	Midge	Chironomidae	1, 2
55	*Dendrocoelum lacteum*	14,880.09	14,880.09	Planaria	Planariidae	1, 2
54	*Orconectes virilis*	<11,193.54	11,097.25	Crayfish	Cambaridae	1, 2
	Orconectes immunis		<11,371.23	Crayfish	Cambaridae	1, 2
53	*Oreochromis mossambica*	10,068.09	10,068.09	Tilapia	Cichlidae	2
52	*Gasterosteus aculeatus*	5,897.00	5,897.00	Threespine stickleback	Gasterosteidae	2
51	*Gambusia affinis*	5,578.08	5,578.08	Mosquitofish	Poeciliidae	2
50	*Ictalurus punctatus*	4,994.42	4,994.42	Channel catfish	Ictaluridae	2
49	*Lepomis cyanellus*	4,812.28	3,595.94	Green sunfish	Centrarchidae	2
	Lepomis macrochirus		6,440.04	Bluegill	Centrarchidae	2
48	*Rhyacodrilus montana*	4,912.28	4,912.28	Tubificid worm	Tubificidae	1, 2
47	*Cyprinus carpio*	4,547.36	4,547.36	Common carp	Cyprinidae	2
46	*Stylodrilus heringianus*	4,228.50	4,228.50	Tubificid worm	Tubificidae	1, 2
45	*Notropis lutrensis*	4,051.76	4,051.76	Red shiner	Cyprinidae	2
44	*Spirosperma ferox*	3,094.45	2,729.04	Tubificid worm	Tubificidae	1, 2
	Spirosperma nikolskyi		3,508.77	Tubificid worm	Tubificidae	1, 2
43	*Varichaeta pacifica*	2,962.96	2,962.96	Tubificid worm	Tubificidae	1, 2
42	*Jordanella floridae*	2,810.24	2,810.24	Flagfish	Cyprinodontidae	1, 2
41	*Catostomus commersoni*	2,827.16	2,827.16	White sucker	Catostomidae	1, 2
40	*Poecilia reticulata*	2,569.18	2,569.18	Guppy	Poeciliidae	2
39	*Quistradilus multisetosus*	2,495.13	2,495.13	Tubificid worm	Tubificidae	1, 2

TABLE 4 - Revised: Continued.

Rank	Species	GMAV (µg/L)	SMAV (µg/L)	Common Name	Family	Code
15	*Xyrauchen texanus*	42.13	42.13	Razorback sucker	Catostomidae	2
14	*Lophopodella carteri*	41.24	41.24	Bryozoan	Lophopodidae	1, 2
13	*Vilosa vibex*	37.18	37.18	Mussel	Unionidae	1, 2
12	*Actinonaia pectorosa*	35.59	35.59	Mussel	Unionidae	1, 2
11	*Lampsilis straminea claibornensis*	33.00	46.61	Mussel	Unionidae	1, 2
	Lampsilis teres		23.37	Mussel	Unionidae	1, 2
10	*Pimephales promelas*	28.45	28.45	Fathead minnow	Cyprinidae	2
9	*Daphnia magna*	27.43	15.36	Cladoceran	Daphnidae	1, 2
	Daphnia pulex		48.98	Cladoceran	Daphnidae	1, 2
8	*Simocephalus serrulatus*	27.79	27.79	Cladoceran	Daphnidae	1, 2
7	*Ptychocheilus lucius**	25.93	25.93	Colorado pikeminnow	Cyprinidae	2
	Ptychocheilus oregonensis		2,070.47	Northern pikeminnow	Cyprinidae	2
6	*Hyallela azteca*	7.51	7.51	Amphipod	Hyalellidae	1, 2
5	*Thymallus arcticus*	4.80	4.80	Arctic grayling	Salmonidae	1
4	*Oncorhynchus kisutch*	3.47	5.72	Coho salmon	Salmonidae	1
	Oncorhynchus tshawytscha		3.98	Chinook salmon	Salmonidae	1
	Oncorhynchus mykiss		1.84	Rainbow trout	Salmonidae	1
3	*Morone saxatilis*	3.16	3.16	Striped bass	Percichthyidae	2
2	*Salmo trutta*	2.95	2.95	Brown trout	Salmonidae	1
1	*Salvelinus fontinalis*	1.91	<1.76	Brook trout	Salmonidae	1
	Salvelinus confluentus		2.08	Bull trout	Salmonidae	1

[1] Used in cold water calculations.
[2] Used in warm water calculations.
* Only the most sensitive species was used to calculate the GMAV .

Revised Table 6 from CEC 2004 report entitled "U.S. EPA Cadmium Water Quality Criteria Document –Technical Review and Criteria Update" prepared for AMSA.

TABLE 6 - Revised: Updated acute cadmium hardness slope. SMAS = species mean acute slope (*revised December 2004*).

Species	hardness (mg/L)	geomean (hardness)	normalized hardness	LC_{50}/EC_{50} (µg/L)	geomean (acute)	normalized acute	Reference	ln (norm hard)	ln (norm acute)	SMAS	R^2
Limnodrilus hoffmeisteri	5.3		0.19	170.00		0.27	Chapman *et al.* 1982	-1.678	-1.324		--
Limnodrilus hoffmeisteri	152.0	28.38	5.36	2,400.00	638.75	3.76	Williams *et al.* 1985	1.678	1.324	0.7888	--
Tubifex tubifex	128.0		2.89	3,200.00		2.66	Reynoldson *et al.* 1996	1.061	0.978		
Tubifex tubifex	128.0		2.89	1,700.00		1.41	Reynoldson *et al.* 1996	1.061	0.346		
Tubifex tubifex	5.3	44.28	0.12	320.00	1,202.96	0.27	Chapman *et al.* 1982	-2.123	-1.324	0.6238	0.93
Vilosa vibex	40.0		0.46	30.00		0.49	Keller as cited in U.S. EPA 2001	-0.768	-0.714		
Vilosa vibex	186.0	86.26	2.16	125.00	61.24	2.04	Keller as cited in U.S. EPA 2001	0.768	0.714	0.9286	--
Daphnia magna	51.0		0.43	9.90		0.31	Chapman *et al.* Manuscript	-0.839	-1.178		
Daphnia magna	104.0		0.88	33.00		1.03	Chapman *et al.* Manuscript	-0.127	0.026		
Daphnia magna	105.0		0.89	34.00		1.06	Chapman *et al.* Manuscript	-0.117	0.056		
Daphnia magna	197.0		1.67	63.00		1.96	Chapman *et al.* Manuscript	0.512	0.673		
Daphnia magna	209.0	118.05	1.77	49.00	32.14	1.52	Chapman *et al.* Manuscript	0.571	0.422	1.1824	0.91
Daphnia pulex	57.0		0.60	47.00		0.53	Bertram and Hart 1979	-0.508	-0.636		
Daphnia pulex	240.0		2.53	319.00		3.59	Elnabarawy *et al.* 1986	0.930	1.279		
Daphnia pulex	120.0		1.27	80.00		0.90	Hall *et al.* 1986	0.237	-0.104		
Daphnia pulex	120.0		1.27	100.00		1.13	Hall *et al.* 1986	0.237	0.119		
Daphnia pulex	53.5		0.56	70.10		0.79	Stackhouse and Benson 1988	-0.571	-0.236		
Daphnia pulex	85.0		0.90	66.00		0.74	Roux *et al.* 1993	-0.108	-0.296		
Daphnia pulex	85.0		0.90	99.00		1.12	Roux *et al.* 1993	-0.108	0.109		
Daphnia pulex	85.0	94.71	0.90	70.00	88.74	0.79	Roux *et al.* 1993	5.52	-0.237	1.0633	0.79
Oncorhynchus tshawytscha	211.0		4.05	26.00		5.27	Hamilton and Buhl 1990	1.398	1.661		
Oncorhynchus tshawytscha	343.0		6.58	57.00		11.55	Hamilton and Buhl 1990	1.884	2.446		
Oncorhynchus tshawytscha	23.0		0.44	1.80		0.36	Chapman 1975, 1978	-0.819	-1.009		

TABLE 6 - Revised: Continued.

Species	hardness (mg/L)	geomean (hardness)	normalized hardness	LC_{50}/EC_{50} (µg/L)	geomean (acute)	normalized acute	Reference	ln (norm hard)	ln (norm acute)	SMAS	R^2
Morone saxatilis	40.0		0.66	4.00		1.34	Palawski *et al.* 1985	-0.417	0.291		
Morone saxatilis	285.0	60.69	4.70	10.00	2.99	3.34	Palawski *et al.* 1985	1.547	1.207	0.8089	0.72
Morone saxatilis	20.0		0.17	2,840.00		0.20	Pickering and Henderson 1966	-1.790	-1.631		
Lepomis cyanellus	360.0		3.00	66,000.00		4.55	Pickering and Henderson 1966	1.100	1.515		
Lepomis cyanellus	85.5		0.71	11,520.00		0.79	Carrier and Beitinger 1988b	-0.338	-0.230		
Lepomis cyanellus	335.0	119.84	2.80	20,500.00	14,504.98	1.41	Jude 1973	1.028	0.346	0.8986	0.88
Lepomis macrochirus	20.0		0.56	1,940.00		0.46	Pickering and Henderson 1966	-0.585	-0.786		
Lepomis macrochirus	18.0		0.50	2,300.00		0.54	Bishop and McIntosh 1981	-0.690	-0.616		
Lepomis macrochirus	18.0		0.50	2,300.00		0.54	Bishop and McIntosh 1981	-0.690	-0.616		
Lepomis macrochirus	207.0		5.77	21,100.00		4.95	Eaton 1980	1.752	1.600		
Lepomis macrochirus	44.4	35.89	1.24	6,470.00	4,258.80	1.52	Phipps and Holcombe 1985	0.213	0.418	0.9531	0.95
Oncorhynchus mykiss	420.0		6.93	7.40		4.04	Davies *et al.* 1993	1.935	1.397		
Oncorhynchus mykiss	427.0		7.04	5.92		3.23	Davies *et al.* 1993	1.952	1.174		
Oncorhynchus mykiss	217.0		3.58	4.20		2.29	Davies *et al.* 1993	1.275	0.830		
Oncorhynchus mykiss	227.0		3.74	6.57		3.59	Davies *et al.* 1993	1.320	1.278		
Oncorhynchus mykiss	46.0		0.76	2.64		1.44	Davies *et al.* 1993	-0.276	0.366		
Oncorhynchus mykiss	49.0		0.81	3.08		1.68	Davies *et al.* 1993	-0.213	0.520		
Oncorhynchus mykiss	23.0		0.38	1.30		0.71	Chapman 1975, 1978	-0.969	-0.342		
Oncorhynchus mykiss	23.0		0.38	1.00		0.55	Chapman 1978	-0.969	-0.605		
Oncorhynchus mykiss	31.0		0.51	1.75		0.96	Davies 1976	-0.671	-0.045		
Oncorhynchus mykiss	44.4		0.73	3.00		1.64	Phipps and Holcombe 1985	-0.312	0.494		
Oncorhynchus mykiss	30.7		0.51	0.71		0.39	Stratus Consulting 1999	-0.681	-0.947		
Oncorhynchus mykiss	29.3		0.48	0.47		0.26	Stratus Consulting 1999	-0.727	-1.360		
Oncorhynchus mykiss	31.7		0.52	0.51		0.28	Stratus Consulting 1999	-0.649	-1.278		
Oncorhynchus mykiss	30.2		0.50	0.38		0.21	Stratus Consulting 1999	-0.697	-1.572		

Revised Table 8 from CEC 2004 report entitled "U.S. EPA Cadmium Water Quality Criteria Document–Technical Review and Criteria Update" prepared for AMSA.

TABLE 8 Revised: Updated chronic cadmium hardness slope. SMCS = species mean chronic slope (*revised December 2004*).

Species	hardness (mg/L)	geomean (hard)	normalized hardness	chronic value (µg/L)	geomean (chronic)	normalized chronic	Reference	ln (norm hard)	ln (norm acute)	SMCS	R^2
Daphnia magna	209.2		1.68	0.67		2.15	Canton and Slooff 1982	0.5206	0.7654		
Daphnia magna	53.0		0.43	1.52		0.49	Chapman *et al.* manuscript	-0.8524	-0.7180		
Daphnia magna	103.0		0.83	0.21		0.68	Chapman *et al.* manuscript	-0.1879	-0.3853		
Daphnia magna	209.0	124.30	1.68	0.44	0.31	1.40	Chapman *et al.* manuscript	0.5197	0.3380	0.9659	0.89
Salmo trutta	39.8		0.52	1.33		0.25	Davies and Brinkman 1994	-0.65	-1.38		
Salmo trutta	44.0		0.58	6.67		1.27	Eaton *et al.* 1978	-0.55	-0.24		
Salmo trutta	250.0	75.93	3.29	16.49	5.27	3.13	Brown *et al.* 1994	1.19	1.14	0.9931	0.65
Pimephales promelas	201.0		2.14	45.92		2.14	Pickering and Gast 1972	0.76	0.76		
Pimephales promelas	44.0	94.04	0.47	10.00	21.43	0.47	Spehar and Fiandt 1986	-0.76	-0.76	1.0034	--
Oncorhynchus mykiss	46.2		0.26	1.47		0.49	Davies *et al.* 1993	-1.36	-0.72		
Oncorhynchus mykiss	217.0		1.21	3.58		1.19	Davies *et al.* 1993	0.19	0.17		
Oncorhynchus mykiss	413.8		2.31	3.64		1.21	Davies *et al.* 1993	0.84	0.19		
Oncorhynchus mykiss	250.0	179.46	1.39	4.31	3.01	1.43	Brown *et al.* 1994	0.33	0.36	0.4779	0.86
							Revised pooled chronic slope =			**0.7998**	**0.72**

Revised Table 10 from CEC 2004 report entitled "U.S. EPA Cadmium Water Quality Criteria Document –Technical Review and Criteria Update" prepared for AMSA.

TABLE 10 - Revised: Cadmium acute-chronic ratio. Only **bold** values were used in the final calculation (*revised December 2004*).

Species	Reference	Hardness	Acute Value	Chronic Value	Ratio	SMAV	SMACR
Jordanella floridae	Spehar 1976	44.0	2,500.00	5.76	433.80	2,810.24	433.8018
Lepomis macrochirus	Eaton 1974	207.0	21,100.00	49.80	423.70	6,440.04	423.6948
Aplexa hypnorum	Holcombe *et al.* 1984	45.3	93.00	5.80	16.03	102.73	20.7584
Aplexa hypnorum	Holcombe *et al.* 1984	45.3	93.00	3.46	26.88		
Ceriodaphnia dubia	Suedel *et al.* 1997	17.0	63.10	2.00	31.55	49.86	31.5500
Pimephales promelas	Pickering and Gast 1972	201.0	5,995.00	45.92	130.55	28.45	**13.1275**
Pimephales promelas	Spehar and Fiandt 1986	44.0	13.20	10.00	1.32		
Daphnia magna	Canton and Sloof 1982	209.2	30.00	0.67	44.78	15.36	44.7751
Oncorhynchus tshawytscha	Chapman 1975, 1982	25.0	1.41	1.56	0.90	3.98	**0.9021**
*Oncorhynchus mykiss**	Davies *et al.* 1993	400.0	7.40	3.64	2.03	1.84	**1.7298**
*Oncorhynchus mykiss**	Davies *et al.* 1993	400.0	5.92	3.64	1.63		
*Oncorhynchus mykiss**	Davies *et al.* 1993	200.0	4.20	3.58	1.17		
*Oncorhynchus mykiss**	Davies *et al.* 1993	200.0	6.57	3.58	1.84		
*Oncorhynchus mykiss**	Davies *et al.* 1993	50.0	2.64	1.47	1.80		
*Oncorhynchus mykiss**	Davies *et al.* 1993	50.0	3.08	1.47	2.10		
				Final acute-chronic ratio =			**2.7362**

* Acute values were grouped with chronic values of like target hardness values.

Other Changes/Comments Addressed in the Revision

- As noted by CDOW, methods for the Davies and Brinkman tests (1994) were corrected from renewal to flow-through. This allowed inclusion of the data in the revised calculations.

- In response to the CDOW request for clarification, we should note the U.S. EPA criteria guidance (Stephan *et al.* 1985) states that results from flow tests are to be preferentially used for SMAV calculations when flow-through, static, and/or renewal tests are available for a given species. Additionally, only results from tests in which cadmium was measured were used to calculate SMAVs if both measured and unmeasured data were available for a given species, again following U.S. EPA criteria guidelines.

APPENDIX A

Acute and Chronic Toxicity Databases

Species	Common Name	Method	Chemical	Hardness (mg/L) as $CaCO_3$	LC_{50}, total ug/L	LC_{50} adj to hardness=50	SMAV*	Ref
Lampsilis straminea claibornensis	Mussel (juvenile)	S, M, T	–	40	38	46.61	46.61	Keller unpublished
Lampsilis teres	Mussel	S, M, T	–	40	11	13.49	23.37	Keller unpublished
Lampsilis teres	Mussel (juvenile)	S, M, T	–	40	33	40.48		Keller unpublished
Utterbackia imbecilis	Mussel (juvenile)	S, M, T	Cadmium chloride	90.0	114.7	66.98	44.90	Keller unpublished
Utterbackia imbecilis	Mussel (juvenile)	S, M, T	Cadmium chloride	90.0	111.8	65.29		Keller unpublished
Utterbackia imbecilis	Mussel (juvenile)	S, M, T	Cadmium chloride	92.0	81.9	46.88		Keller unpublished
Utterbackia imbecilis	Mussel (juvenile)	S, M, T	Cadmium chloride	86.0	93	56.62		Keller unpublished
Utterbackia imbecilis	Mussel (juvenile)	S, M, T	Cadmium chloride	39.0	9	11.30		Keller and Zam 1991
Utterbackia imbecilis	Mussel (juvenile)	S, M, T	Cadmium chloride	90.0	107	62.49		Keller and Zam 1991
Vilosa vibex	Mussel	S, M, T	–	40.0	30	36.80	37.18	Keller unpublished
Vilosa vibex	Mussel	S, M, T	–	186.0	125	37.57		Keller unpublished
Alona affinis	Cladoceran	S, U	Cadmium nitrate	109	546	267.59	267.59	Ghosh et al. 1990
Ceriodaphnia dubia	Cladoceran (<24 hr)	S, U	Cadmium chloride	90 (80-100)	54	31.54	49.86	Bitton et al. 1996
Ceriodaphnia dubia	Cladoceran (<24 hr)	R, M, T	Cadmium chloride	80 (70-90)	54.5	35.45		Diamond et al. 1997
Ceriodaphnia dubia	Cladoceran (<24 hr)	S, U	Cadmium chloride	90 (80-100)	55.9	32.64		Lee et al. 1997
Ceriodaphnia dubia	Cladoceran	S, M, T	Cadmium chloride	17	63.1	169.35		Suedel et al. 1997
Ceriodaphnia reticulata	Cladoceran (<24 hr)	S, U	Cadmium chloride	240	184	43.79	46.50	Elnabarawy et al. 1986
Ceriodaphnia reticulata	Cladoceran (<6 hr)	S, U	Cadmium chloride	120	110	49.37		Hall et al. 1986
Daphnia magna	Cladoceran	S, U	Cadmium chloride	45	65	71.58	15.36	Biesinger and Christensen 1972

Species	Common Name	Method	Chemical	Hardness (mg/L) as $CaCO_3$	LC_{50}, total ug/L	LC_{50} adj to hardness=50	SMAV*	Ref
Daphnia magna	Cladoceran	S, M, T	Cadmium sulfate	179	233 (clone S-1)	72.53		Barata et al. 1998
Daphnia magna	Cladoceran	S, M, T	Cadmium sulfate	46.1	30.1 (clone A)	32.42		Barata et al. 1998
Daphnia magna	Cladoceran	S, M, T	Cadmium sulfate	90.7	23.4 (clone A)	13.57		Barata et al. 1998
Daphnia magna	Cladoceran	S, M, T	Cadmium sulfate	179	23.6	7.35		Barata et al. 1998
Daphnia magna	Cladoceran (<24 hr)	S, M, T	Cadmium chloride	51	9.9	9.72		Chapman et al. manuscript
Daphnia magna	Cladoceran (<24 hr)	S, M, T	Cadmium chloride	104	33	16.88		Chapman et al. manuscript
Daphnia magna	Cladoceran (<24 hr)	S, M, T	Cadmium chloride	105	34	17.24		Chapman et al. manuscript
Daphnia magna	Cladoceran (<24 hr)	S, M, T	Cadmium chloride	197	63	17.96		Chapman et al. manuscript
Daphnia magna	Cladoceran (<24 hr)	S, M, T	Cadmium chloride	209	49	13.24		Chapman et al. manuscript
Daphnia magna	Cladoceran	S, M, T	Cadmium chloride	17	26.4	70.85		Suedel et al. 1997
Daphnia pulex	Cladoceran	S, U	Cadmium chloride	57	47	41.69	48.98	Bertram and Hart 1979
Daphnia pulex	Cladoceran (<24 hr)	S, U	Cadmium chloride	240	319	75.93		Elnabarawy et al 1986
Daphnia pulex	Cladoceran (<24 hr)	S, U	Cadmium chloride	120	80	35.91		Hall et al 1986
Daphnia pulex	Cladoceran (<24 hr)	S, U	Cadmium chloride	120	100	44.88		Hall et al 1986
Daphnia pulex	Cladoceran (<24 hr)	S, M, T	Cadmium chloride	53.5	70.1	65.89		Stackhouse and Benson 1988
Daphnia pulex	Cladoceran	S, U	Cadmium chloride	85 (80-90)	66	40.61		Roux et al. 1993
Daphnia pulex	Cladoceran	S, U	Cadmium chloride	85 (80-90)	99	60.92		Roux et al. 1993
Daphnia pulex	Cladoceran	S, U	Cadmium chloride	85 (80-90)	70	43.07		Roux et al. 1993
Daphnia pulex	Cladoceran	S, U	Cadmium chloride	82	71.25	45.31		Hatakeyama and Yasuno

Species	Common Name	Method	Chemical	Hardness (mg/L) as $CaCO_3$	LC_{50}, total ug/L	LC_{50} adj to hardness=50	SMAV*	Ref
Plumatella emarginata	Bryozoan	S, U	--	205 (190-220)	1090	299.69	299.69	Pardue and Wood 1980
Oncorhynchus kisutch	Coho salmon (parr)	F, M	Cadmium chloride	22	2.7	5.72	5.72	Chapman 1975
Oncorhynchus tshawytscha	Chinook salmon (swim-up)	F, M	Cadmium chloride	23	1.8	3.66	3.98	Chapman 1975, 1978
Oncorhynchus tshawytscha	Chinook salmon *	F, M	Cadmium*	23	3.5	7.12		Chapman 1975, 1978
Oncorhynchus tshawytscha	Chinook salmon (smolt)	F, M	Cadmium chloride	23	2.9	5.90		Chapman 1975, 1978
Oncorhynchus tshawytscha	Chinook salmon (juvenile)	F, M	Cadmium chloride	25	1.41	2.66		Chapman 1982
Oncorhynchus tshawytscha	Chinook salmon (juvenile)	F, M	Cadmium sulfate	21 (20-22)	1.1	2.43		Finlayson and Verrue 1982
Oncorhynchus mykiss	Rainbow trout (swim-up)	F, M	Cadmium chloride	23	1.3	2.65	1.84	Chapman 1975, 1978
Oncorhynchus mykiss	Rainbow trout (parr)	F, M	Cadmium chloride	23	1	2.04		Chapman 1978
Oncorhynchus mykiss	Rainbow trout (smolt)	F, M	Cadmium chloride	23	4.1	8.34		Chapman 1975
Oncorhynchus mykiss	Rainbow trout (smolt)	F, M	Cadmium chloride	23	2.9	5.90		Chapman 1975
Oncorhynchus mykiss	Rainbow trout	F, M	Cadmium sulfate	31	1.75	2.71		Davies 1976
Oncorhynchus mykiss	Rainbow trout (8.8 g)	F, M, T	Cadmium chloride	44.4	3	3.34		Phipps and Holcombe 1985
Oncorhynchus mykiss	Rainbow trout (fry)	F, M, T	Cadmium chloride	9.2	0.5	2.35		Cusimano et al. 1986
Oncorhynchus mykiss	Rainbow trout (263 g)	F, M, T	Cadmium chloride	30.7 (pH=7.5 @ 8°C)	0.71	1.11		Stratus Consulting 1999
Oncorhynchus mykiss	Rainbow trout (259 g)	F, M, T	Cadmium chloride	29.3 (pH=7.5 @ 8°C)	0.47	0.77		Stratus Consulting 1999

Species	Common Name	Method	Chemical	Hardness (mg/L) as $CaCO_3$	LC_{50}, total ug/L	LC_{50} adj to hardness=50	SMAV*	Ref
Salvelinus confluentus	Bull trout (200 mg)	F, M, T	Cadmium	29.3	0.99	1.61		Stratus Consulting 1999
Salvelinus confluentus	Bull trout (221 mg)	F, M, T	Cadmium chloride	31.7	1	1.52		Stratus Consulting 1999
Salvelinus confluentus	Bull trout (218 mg)	F, M, T	Cadmium chloride	30.2	0.9	1.43		Stratus Consulting 1999
Salvelinus confluentus	Bull trout (84.2 mg)	F, M, T	Cadmium chloride	30	2.89	4.61		Stratus Consulting 1999
Salvelinus confluentus	Bull trout (72.7 mg)	F, M, T	Cadmium chloride	89.3	6.06	3.56		Stratus Consulting 1999
Carssius auratus	Goldfish (8.8 g)	F, M, T	Cadmium chloride	44.4	748	833.89	833.89	Phipps and Holcombe 1985
Cyprinus carpio	Common carp (fry)	S, U	Cadmium nitrate	100	4300	2280.32	4547.36	Suresh et al. 1993
Cyprinus carpio	Common carp (fingerling)	S, U	Cadmium nitrate	100	17100	9068.25		Suresh et al. 1993
Notropis lutrensis	Red shiner	S, M, T	Cadmium *	85.5	6620	4051.76	4051.76	Carrier and Beitinger 1988
Pimephales promelas	Fathead minnow (fry)	S, M	Cadmium chloride	40.0	21.5	26.37	28.45	Spehar 1982
Pimephales promelas	Fathead minnow (fry)	S, M	Cadmium chloride	48.0	11.7	12.15		Spehar 1982
Pimephales promelas	Fathead minnow (fry)	S, M	Cadmium chloride	39.0	19.3	24.23		Spehar 1982
Pimephales promelas	Fathead minnow (fry)	S, M	Cadmium chloride	45.0	42.4	46.69		Spehar 1982
Pimephales promelas	Fathead minnow (fry)	S, M	Cadmium chloride	47.0	54.2	57.36		Spehar 1982
Pimephales promelas	Fathead minnow (fry)	S, M	Cadmium chloride	44.0	29	32.60		Spehar 1982
Pimephales promelas	Fathead minnow (<24 hr)	S, U	Cadmium nitrate	60.0	210	177.73		Rifici et al. 1996
Pimephales promelas	Fathead minnow (1-2 d)	S, U	Cadmium nitrate	60.0	180	152.34		Rifici et al. 1996
Pimephales promelas	Fathead minnow (<24 hr)	S, M, T	Cadmium nitrate	290.0	73	14.61		Schubauer-Berigan et al. 1993

Species	Common Name	Method	Chemical	Hardness (mg/L) as $CaCO_3$	LC_{50}, total ug/L	LC_{50} adj to hardness=50	SMAV*	Ref
Poecilia reticulata	Guppy	S, U	Cadmium chloride	20.0	1270	2937.37	2569.18	Pickering and Henderson 1966
Poecilia reticulata	Guppy (3-4 wk)	R, M, T	Cadmium chloride	105.0	3800	1927.17		Canton and Sloof 1982
Poecilia reticulata	Guppy (3-4 wk)	R, M, T	Cadmium chloride	209.2	11100	2995.74		Canton and Sloof 1982
Gasterosteus aculeatus	Threespine stickleback	S, U	Cadmium chloride	115	6500	3033.17	5897.00	Pascoe and Cram 1977
Gasterosteus aculeatus	Threespine stickleback	R, M	Cadmium chloride	107	23000	11464.79		Pascoe and Mattey 1977
Morone saxatilis	Striped bass (63 d)	S, U	Cadmium chloride	40	4	4.91	3.16	Palawski 1973
Morone saxatilis	Striped bass (63 d)	S, U	Cadmium chloride	285	10	2.03		Palawski 1973
Lepomis cyanellus	Green sunfish	F, M	Cadmium *	335	20500	3595.94	3595.94	Jude 1973
Lepomis macrochirus	Bluegill	F, M	Cadmium chloride	207	21100	5749.97	6440.04	Eaton 1980
Lepomis macrochirus	Bluegill (1.0 g)	F, M, T	Cadmium chloride	44.4	6470	7212.93		Phipps an dHolcombe1985
Oreochromis mossambica	Tilapia	R, U	Cadmium chloride	28.4	6000	10068.09	10068.09	Gaikwad 1989
Ambystoma gracile	Salamander	F, M, T	Cadmium chloride	45	468.4	515.81	515.81	Nebeker et al. 1995
Thymallus arcticus	Arctic grayling (juvenile)	S, M, T	Cadmium chloride	41.0	4	4.80	4.80	Buhl and Hamilton 1991

*value taken from 1984 document

** values estimated from dissolved Cd before updated in study

Species	Common Name	Test	Chemical	Hardness(mg/L as$CaCO_3$)	Chronic limits, total (µg/L)	Chronicvalue total (µg/L)	Chronic value/EC_{20}s hardness=50	SMCV	GMCV	Ref
Chironomus tentans	Midge	LC	Cadmium chloride	280	5.8-17.4	10.05	2.534	2.5338	2.5338	Ingersoll and Kemble Unpublished
Pimephales promelas	Fathead minnow	LC	Cadmium sulfate	201	37-57	45.92	15.092	15.0918	15.0918	Pickering and Gast 1972
Catostomus commersoni	White sucker	ELS	Cadmium chloride	44	4.2-12.0	7.099	7.863	7.8632	7.8632	Eaton et al. 1978
Jordanella floridae	Flagfish	LC	Cadmium chloride	44	4.1-8.1	5.763	6.383	5.3420	5.3420	Spehar 1976
Jordanella floridae	Flagfish	LC	Cadmium chloride	47.5	3.0-6.5	4.416	4.601			Carlson et al. 1982
Jordanella floridae	Flagfish	LC	Cadmium chloride	47.5	3.4-7.3	4.982	5.191			Carlson et al. 1982
Lepomis macrochirus	Bluegill	LC	Cadmium sulfate	207	31-80	49.8	15.986	15.9865	15.9865	Eaton et al. 1978
Micropterus dolomieui	Smallmouth bass	ELS	Cadmium chloride	44	4.3-12.7	7.39	8.186	8.1855	8.1855	Eaton et al. 1978
Oreochromis aurea	Blu tilapia	LC	Cadmium nitrate	145	>52	52	22.191	22.1910	22.1910	Papoutsoglou and Abel 1988
Oncorhynchus kisutch	Coho salmon	ELS	Cadmium chloride	44	1.3-3.4	2.102	2.328	4.2968	2.3320	Eaton et al. 1978
Oncorhynchus kisutch	Coho salmon	ELS	Cadmium chloride	44	4.1-12.5	7.159	7.930			Eaton et al. 1978
Oncorhynchus tshawytscha	Chinook salmon	ELS	Cadmium chloride	25	1.3-1.88	1.563	2.721	2.7210		Chapman 1975
Oncorhynchus mykiss	Rainbow trout	LC	Cadmium chloride	46.2		1.47	1.566	1.0847		Davies et al. 1993
Oncorhynchus mykiss	Rainbow trout	LC	Cadmium chloride	217		3.58	1.107			Davies et al. 1993
Oncorhynchus mykiss	Rainbow trout	LC	Cadmium chloride	413.8		3.64	0.671			Davies et al. 1993
Oncorhynchus mykiss	Rainbow trout (270 d)	LC	Cadmium sulfate	250	3.39-5.48	4.31	1.190			Brown et al. 1994

North Carolina Pretreatment Consortium, Inc.

September 1, 2006

Ms. Connie Brower [via fax 9-1-2006]
DENR/Division of Water Quality- Planning Branch
1617 Mail Service Center
Raleigh, NC 27699-1617

Subject: Comments on the NC Triennial Review: Proposed Revision to the Aquatic Life Standard for Cadmium

Dear Ms. Brower:

The North Carolina Pretreatment Consortium, Incorporated is a non-profit organization representing over 140 pretreatment professionals from municipalities throughout the State of North Carolina. Since its inception in 1997, the Pretreatment Consortium has grown to represent 120 of the state's 125 pretreatment programs. North Carolina's pretreatment programs cover 147 municipal wastewater treatment plants with a combined NPDES permitted flow of over 900 MGD, more than 90% of all municipal NPDES permitted flow in the state. Our organization is writing to express concerns about the proposed revisions to the water quality standard for cadmium. We believe this standard is overly protective of many surface waters in North Carolina and will have unforeseen impacts on the regulated community, particularly industries regulated under the NC Pretreatment Program.

North Carolina has a history of looking closely at EPA criteria as well as other water quality standards guidance and adopting standards and rules that are specifically crafted for North Carolina. The proposed direct adoption of the EPA chronic criterion for cadmium as a water quality standard with no review or consideration of the appropriateness for the state is inconsistent with this history.

There are several points that we want to make regarding the proposed change to the cadmium standard and have recommendations for additional review. The major points can be summarized as follows:

1. Adoption of the EPA criterion for cadmium is not consistent with previous NC efforts to have separate criteria for designated trout and non-trout waters

2. Several states have taken issue with the EPA criterion and at least one has had alternative criteria approved and another is pursuing the resident species approach for statewide criteria

3. There are no waters identified in NC specifically impaired by cadmium

4. The hidden impacts of the reducing the cadmium criterion could be severe for industrial contributors to municipal systems

Each of these points is discussed briefly below followed by recommendations.

1. Inconsistency with Previous NC Water Quality Standard

In the 1980s, the Division of Environmental Management (DEM) Water Quality Planning staff determined that the Final Acute Value and the chronic values from EPA's 1984 criteria document were significantly influenced by coldwater species, principally trout and salmonids. While the EPA national criteria were calculated directly from available chronic and acute data [rather than using acute data and an acute to chronic ratio (ACR) similar to other criteria], DEM chose to propose different standards for trout waters (0.7 ug/L) and non-trout waters (2.0 ug/L) based on hardness values of 25 and 50 mg/L, respectively. This decision was based on providing an appropriate level of protection for both trout and non-trout waters.

As will be discussed below, there is still considerable information that points to consideration of separate criteria for trout and non-trout waters. There may also be additional data for aquatic species in the database used to calculate the national criterion that are not appropriate for North Carolina waters. It seems reasonable that a careful review of available data and potential recalculation of criteria be considered prior to revising the water quality standard.

Although water quality standards in North Carolina have generally been based on a hardness of 50 mg/L, adoption of a single standard based on this hardness may be overly protective for effluent dominated streams where hardness may be considerably higher than 50 mg/L under low flow conditions used for development of permit limitations. In addition, the standard based on a hardness of 50 mg/L may not fully protect very low hardness streams, especially trout waters.

2. Issues with EPA 2001 Cadmium Criteria

The National Association of Clean Water Agencies (NACWA) funded a study by Chadwick Ecological Consultants (CEC) to review the EPA criterion[1]. In this review, CEC discovered several issues with EPA acute and chronic data and procedures for developing the national criteria. They also identified several additional sources of data to be added to the database for deriving the national criteria. CEC proposed alternative coldwater and warm water acute and chronic criteria. In December 2004, CEC published an addendum to its earlier review specifically for agencies within the State of Colorado[2]. EPA took issue with several of the review points and suggestions by CEC but ultimately accepted water quality standards modifications for the state of Colorado that included separate acute criteria equations (based on hardness) for warm water and coldwater streams, and a modified chronic criteria equation.

---

[1] Chadwick Ecological Consultants, Inc. *U.S. EPA Cadmium Criteria Document – Technical Review and Criteria Update.* Littleton, CO. September, 2004.

[2] Chadwick Ecological Consultants, Inc. *Addendum to U.S. EPA Cadmium Criteria Document -- Technical Review and Criteria Update.* Littleton, CO. December, 2004.

In addition, the State of Idaho is working on development of specific criteria for the State using resident species procedures. Details of this report are not yet publicly available.

These prior reviews would be useful starting points to improve upon the previous standard development work in NC where separate standards were developed for trout and other surface waters. This could be accomplished in a reasonable time frame and could then be reconsidered through rule-making.

Copies of the Chadwick Ecological Consultants, Inc. Documents have been included for your review.

3. No Impaired Waters Due to Cadmium

While we appreciate the need to keep water quality standards up to date, we believe there is not a major issue with cadmium as a pollutant in North Carolina. No waters have been specifically identified as impaired for cadmium in the most recent 303(d)/305(b) report and few if any surface waters were listed as impaired for metals. While routine analytical testing only detects cadmium to a level of 1 to 2 ug/l, the absence of any impaired waters for cadmium and identification of cadmium in fish tissue at levels of concern supports an approach that allows careful review and development of specific criteria applicable to the waters of the State of North Carolina.

4. Hidden Impacts of the Reducing the Cadmium Criterion

North Carolina has lost a tremendous number of industrial jobs during the last 5 to 10 years and we believe the biggest impact of the proposed revision to the standard will be to industries regulated through the Pretreatment program. Comments were presented at public hearings and additional comments provided to DWQ on how the revised water quality standard may result in cadmium allocations for industrial dischargers being reduced to zero. These impacts are in part the results of how data at non-detectable levels are treated as part of the pretreatment program. In truth, there is little quantitative data on influent cadmium levels, reductions through treatment processes, and resulting residuals and effluent concentrations. By significantly lowering the water quality standard, even for facilities without cadmium limits in their permits (which are the majority of POTWs), the headworks calculations used to derive local pretreatment limits will generally result in zero allocation to industrial contributors to the system. Attached to this statement is a spreadsheet that includes data from twenty-two (22) POTWs in North Carolina that have calculated the Maximum Allowable Headworks Loading if the limit is lowered to 0.16 ug/l. Only six (6) of the facilities were not immediately over-allocated for cadmium. Out of the sixteen (16) POTW's that are over-allocated ten (10) were over-allocated by their domestic loading only.

Many industries will not be able to comply with these limits and we will not be able to collect data to determine whether there is an issue with cadmium or not unless we employ expensive clean metals sampling and analytical methodologies. A review of the types of industries where we have detected trace amounts of cadmium in the past was completed to determine the industrial impact. This list is included in Table 1.

Table 1- Industrial Categories in North Carolina with cadmium detections at ≥ 2 ug/l

Soft Drink Manufacturer	Meat Packers	Potato Chip Manufacturer
Pharmaceutical Manufacturing Facilities	Industrial/Commercial Laundries	Bread/Bakery Product Manufacturing
Personal Care/Personal Hygiene Products Manufacturing Facilities	Circuit Board Manufacturing Facility	Electrical and Electronic Components Manufacturing Facility
Centralized Waste Treatment Facilities	Transportation Equipment Cleaning Facilities	Metal Finishing Facilities
Electroplating Facilities	Textile Facilities	Photofinishing Facilities
Metal Products and Machinery Facilities	Organic Chemical Manufacturing Facilities	Inorganic Chemical Manufacturing Facilities
Chemical Repackaging Facilities	Tire Manufacturing Facility	Printing and Publishing Facilities

The State has indicated that one option to resolve this over-allocation would be to develop site specific criteria for each POTW. This option was investigated - it would require a full Water Effects Ratio (WER) for cadmium to be developed for each site. Since this would be for the development of a chronic criterion the testing and knowledge for data interpretation would be extensive. The cost would be from $45,000 - $75,000 per facility. Since our preliminary information shows an average of 50% of the POTW's in the pretreatment program to have an over-allocation issue based on domestic loadings alone, the potential cost to the POTW's represented by the NC Pretreatment Consortium could be $3.3 to $5.5 million dollars. This does not include a cost to the industries where there is a very small amount of allocation available to give to industries requiring extensive pretreatment of their wastewater prior to discharging to the POTW.

The USEPA Handbook: Septage Treatment and Disposal (1984 Table 3-5) lists cadmium concentrations in septage as ranging from 0.03 mg/L to 10.8 mg/L. Any POTW overallocated for cadmium or with limited cadmium allocation available would not be able to accept domestic septage into the POTW.

Recommendations

Based the issues identified above, the NC Pretreatment Consortium has the following recommendations

- Recommend no change to the water quality standard for cadmium at this time
- Initiate a process to develop standards appropriate in North Carolina that includes the following steps
  - Convene a work group to assist in development of recommendations
  - Gather additional cadmium toxicity information in addition to the reviews cited previously, which may not be exhaustive

- Work with DWQ's Environmental Sciences Section to identify aquatic species that should be included in the recalculation of EPA's criterion for use in North Carolina
- Work with DWQ's Pretreatment staff to evaluate procedures that do not penalize industrial contributors for allocation assumptions when the standard and majority of the analytical data is below detectable levels
- Consider alternative approach for addressing hardness that provides more flexibility in the application of criteria to NPDES permits

• Recommend standards and rule changes to the Environmental Management Commission for adoption.

An e-mail of this statement is being sent out today. A hard copy will be forwarded to your attention.

Also included with this e-mail is a copy of the North Carolina Pretreatment Consortium comments made during the Public Hearing in Raleigh, N.C. on 7/25/06. At the time of the hearing the microphone was not working properly and the statement may not have been recorded.

We will be glad to discuss our concerns and recommendations with you in more detail. Please contact me at 336/433-7229 or Dawn Padgett at 704/357-1344 ext 235.

Sincerely,

Martie Groome Martie Groome

Martie Groome
Chair- North Carolina Pretreatment Consortium, Inc.

Dawn Padgett

Dawn Padgett
NC Pretreatment Consortium Triennial Review Workgroup Leader

Enclosures:

Chadwick Ecological Consultants, Inc. "U.S. EPA Cadmium Criteria Documents-Technical Review and Criteria Update" (September 2004) [via email 9-2-2006]

Chadwick Ecological Consultants, Inc. "Addendum to U.S. EPA Cadmium Criteria Documents-Technical Review and Criteria Update" (December 2004) [via email 9-2-2006]

North Carolina POTW Cadmium Maximum Allowable Headworks Loadings-Comparison of 0.002 mg/l WQS with Proposed 0.00016 mg/l WQS [via fax 9-1-2006]

NC-PC Public Hearing Comments in Raleigh 7-25-2006 [via fax 9-1-2006]

CADMIUM MAXIMUM ALLOWABLE HEADWORKS LOADING COMPARISONS						
POTW	Current MAHL Using 2 ug/l WQS (0.002 mg/l)	MAHL Using 0.16 ug/l (0.00016 mg/l)	Flow Used	Cadmium Domestic Loading	Cadimium Overallocated Using 0.16 ug/l	IWC
Graham	1.21 lbs	0.0972	From Last HWA	0.029 lbs	No	14%
Greensboro-NB	2.7429 lbs	0.2194 lbs	From Last HWA	0.2368 lbs	Yes	96%
Greensboro- TZO	4.5147 lbs	0.3641 lbs	From Last HWA	0.3870 lbs	Yes	97%
Cary	0.3104 lbs	0.0248 lbs	From Last HWA	0.0498 lbs	Yes	98%
Winston-Muddy	18.8155 lbs	1.5052 lbs	From Last HWA	0.202 lbs	Yes	5.5%
Winston-Elledge	1.5012 lbs	0.1201 lbs	From Last HWA	0.252 lbs	Yes	76%
Cabarrus County	1.085 lbs	0.0945 lbs	From Last HWA	0.1677 lbs	Yes	59.6%
Burlington-South	0.4670 lbs	0.0374 lbs	From Last HWA	0.1593 lbs	Yes	86%
Burlington-East	1.3809 lbs	0.1105 lbs	From Last HWA	0.0931 lbs	Yes	36%
High Point-Eastside	0.7276 lbs	0.0582 lbs	From Last HWA	0.2690 lbs	Yes	96%
High Point-Westside	0.2086 lbs	0.0167 lbs	From Last HWA	0.0108 lbs	Yes	93%
Gastonia-Crowders	0.3276 lbs	0.0449 lbs	From Last HWA	0.007 lbs	No	41%
Gastonia-Long	1.0665 lbs	0.3119 lbs	From Last HWA	0.0671 lbs	No	19%
Eden	3.53 lbs	1.0376 lbs	From Last HWA	0.0085 lbs	No	5%
Wilson	0.4490 lbs	0.0342 lbs	From Last HWA	0.0564 lbs	Yes	
Rocky Mount	1.29 pounds	0.2 lbs	From Last HWA	0.186 lbs	Yes	
Clinton	0.1278 lbs	0.0102 lbs	From Last HWA	0.0104 lbs	Yes	100%
Charlotte - Irwin	0.6681 lbs	0.0534 lbs	From Last HWA	0.0286 lbs	Yes	86%
Charlotte - Mallard	0.4691 lbs	0.0375 lbs	From Last HWA	0.0319 lbs	No***	94%
Charlotte - McAlpine	2.2826 lbs	0.1826 lbs	From Last HWA	1.0926 lbs	Yes	98%
Charlotte-Sugar	0.7065 lbs	0.0603 lbs	From Proposed HWA	0.038 lbs	Yes	90%
Moore County	0.7366 lbs	0.0589 lbs	From Last HWA	0.0391	No	41%
***Using 0.0005 mg/l for Domestic concentration						

PUBLIC HEARING COMMENTS
TRIENNIAL REVIEW
JULY 25, 2006 – RALEIGH, NORTH CAROLINA

My name is Martie Groome and I am employed as the Laboratory and Industrial Waste Section Supervisor for the City of Greensboro Water Resources Department. In that capacity, I also serve as the compliance office for Greensboro's two NPDES permits. I have worked for the City of Greensboro in the wastewater operations, laboratory and pretreatment fields for over 30 years.

However, today I am here speaking as the chairman of the North Carolina Pretreatment Consortium Incorporated. The North Carolina Pretreatment Consortium, Incorporated is a non-profit organization representing over 140 pretreatment professionals from municipalities throughout the State of North Carolina. Since its inception in 1997, the Pretreatment Consortium has grown to represent 120 of the state's 125 pretreatment programs. North Carolina's pretreatment programs cover 147 municipal wastewater treatment plants with a combined NPDES permitted flow of over 900 MGD, more than 90% of all municipal NPDES permitted flow in the state.

All decisions, good or bad, result in trade-offs and all decisions, good or bad, result in consequences. A good decision is an educated one. To make an educated decision, the trade offs and consequences must be recognized and then examined and weighed.

The North Carolina Pretreatment Consortium appreciates the opportunity to present the trade-offs and consequences of the proposed change in the North Carolina cadmium water quality standard for freshwaters. The proposal would change the current water quality standard of 2 parts per billion (ppb) to 0.16 ppb, over an order of magnitude reduction.

0.16 parts per billion or micrograms per liter (ug/l) equals 160 parts per trillion (ppt). Let's talk about what we will be trying to measure for a moment. One part per trillion is the equivalent of one inch in 16 million miles----so the new water quality standard is the equivalent of 160 inches in 16 million miles. (The old water quality standard of 2 ppb was the equivalent of 2 inches in 16,000 miles.)

The Pretreatment Consortium is concerned about the consequences of this change on three fronts: laboratory detection levels, implementation of NPDES permit limits and of course, the implications for the pretreatment programs in North Carolina.

Laboratory Detection Limits

There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium down to 160 parts per trillion, nor am I aware of any commercial or municipal laboratory in North Carolina that can measure cadmium to the concentration of the proposed standard.

The current acceptable lower reporting level for EPA approved methods is 2 parts per billion which is equivalent to the current water quality standard.

Most commercial and municipal labs using EPA approved methods can achieve a 2 part per billion detection level on a routine basis. No laboratory in North Carolina can currently achieve a 0.16 part per billion lower reporting level.

NPDES Permit Limits

Wastewater treatment plants located on very low flow streams in North Carolina typically receive the water quality standard as an NPDES permit limit since there is no dilution factor. For instance, the City of Greensboro T. Z. Osborne plant had a cadmium limit of 2 ppb since the current water quality standard is 2 ppb.

If the water quality standard is changed to 0.16 ppb, that limit will be placed in the permits of plants on low flow streams. This puts the municipality in the position of not being able to prove compliance with that limit.

Because there is currently no analytical method to measure to the new limit, a municipality is in the very uncomfortable legal position of being asked by DWQ to accept an NPDES limit that the town has no earthly idea whether they can meet or not.

Certainly, quantitation level language will have to be placed in the permit stating that as long as the plant effluent concentrations are below the lower reporting level of 2 ppb, the plant is considered to be compliant. There is a precedent for this type of permit language for mercury and cyanide. But a decade from now when new laboratory instrumentation is developed to analyze cadmium at part per trillion levels, I predict that virtually every wastewater treatment plant in North Carolina will be in non-compliance and DWQ will say, "You accepted that limit 10 years ago and did not contest it. The time to contest a limit is when it is initially placed in your NPDES permit not during an enforcement action."

Pretreatment Program Consequences

Certainly, there are issues with laboratory detection limits and there are issues with NPDES permit limits but be far the most alarming consequences of the proposed cadmium standard are the implications for the pretreatment program.

The DWQ Pretreatment Section requires the use of the specific water quality standard in Maximum Allowable Headworks Loading calculations regardless of whether that value can be measured in a laboratory.

A Maximum Allowable Headworks Loading calculation results in the amount of cadmium that can be permitted to enter the treatment plant and still mathematically and theoretically have the plant effluent meet the water quality standard. Thus, it is essentially a calculation to determine the how large the "cadmium pie" will be. Then the cadmium pie must be distributed or "allocated" to the various sources of cadmium..... industrial, commercial and domestic entities. In typical circumstances, a piece would be set aside for "domestic sources", another piece would be set aside for all industrial users that discharge cadmium, another piece would be set aside for future growth and a piece would be set aside as a "safety factor".

The use of the proposed cadmium water quality standard will result in overallocation at most wastewater treatment plants with JUST the cadmium coming from domestic sources. Yes there is cadmium coming from household wastes and at part per trillion levels it does not take much of anything to get a few parts per trillion.

For instance, at the smaller City of Greensboro wastewater treatment plant, the MAHL or "cadmium pie" using the current 2 ppb water quality standard was a little over 2 pounds. Using the proposed water quality standard of 0.16 ppb the "cadmium pie" is reduced to approximately 3 ounces...3 ounces for the whole north side of Greensboro serving a population of approximately 80,000 people.....The plant is a 16 MGD plant but only has a flow of about 9.5 MGD and we have already exceeded the 3 ounces....In that situation, DWQ can put a moratorium on our plant and not allow any more discharges that contain cadmium.

In order not to exceed or overallocate this new cadmium pie, all discharges must be significantly less than the current detection limit of 2 ppb. That might sound simple....we'll just shut down all the cadmium electroplaters. However, an examination of the cadmium levels in other types of industries is very interesting. Some food processors have 2 or 3 ppb in their effluents...our meat packers do...the FDA is not alarmed at all with 2 or 3 parts per billion of cadmium. Industrial laundries that just wash uniforms from various work locations have 15 or 16 ppb of cadmium in their wastewater, centralized waste treatment facilities that bring various types of wastewater on-site and pretreat it have detectable levels of cadmium as do virtually all plating operations...even those that do not plate cadmium on site or even have cadmium on site. Cadmium is present at ppb levels in items made of other base metals. All of these facilities will have to be a non-detect in order for a wastewater treatment plant to meet the new cadmium criteria. Most people do not realize it but there are not really any treatment processes that can take cadmium at ppb levels and remove it down to ppt levels. Cadmium pretreatment processes are for much higher concentrations. Yes, it can take 50 ppm down to 0.1 ppm but not ppb to ppt. It is like trying to removing soap from your body during a shower. You can remove 99.9% of the soap but there is really no way to remove the last 0.1% except by taking your skin off! That's where we are in this situation...the last 0.1% or lower.

Many of these facilities will not be able to control the trace levels of cadmium and if we must enforce the new standards on all fronts theses facilities will have no choice but to shut down, particularly all of the metal finishing facilities, even those that do not plate cadmium.

The North Carolina Department of Commerce will not be able to recruit any new industry to North Carolina if their wastewater contains detectable amounts of cadmium, because this new standard will be state-wide and many wastewater treatment plants will have no cadmium pie to give anyone. And we've already talked about the variety of industries that have had cadmium detects.

If wastewater treatment plants are over allocated just with the domestic sources of cadmium, then the cadmium issue is really no longer a pretreatment issue. Pretreatment programs regulate industrial sources and enforce limits on industrial sources. Households are another matter.

If cadmium must be controlled at the part per trillion level, then the FDA and the EPA and North Carolina DWQ need to consider banning the use of cadmium in certain household products, personal care products and household uses. It is now a product source control issue not a pretreatment issue.

The hybrid cars we are so hopeful will solve our petroleum dependence issue...they contain pounds of ni-cad batteries. Many of our other electronic devices contain ni-cad power sources. The "cad" in ni-cad is "cadmium".

<u>Closing Comments</u>

There will be significant consequences in North Carolina if the proposed cadmium standard is adopted and the current NPDES permitting policies and Pretreatment section policies remain the same.

Please understand that the North Carolina Pretreatment Consortium supports the protection of the surface waters of North Carolina. Pretreatment Coordinators are on the front lines of environmental protection. We are in the trenches (and the sewers!) every day regulating industrial discharges to the wastewater treatment plants in North Carolina.

An educated decision must be made on the cadmium issue....and all of the consequences and trade offs must be evaluated.

During the written comment period, the Pretreatment Consortium will be presenting detailed written comments outlining the site-specific impacts on dozens of cities in North Carolina.

Thank you for the opportunity to comment.

Martie Groome
Chair-North Carolina Pretreatment Consortium, Inc.
martie.groome@ci.greensboro.nc.us

CITY OF **Burlington**

Telephone (336) 222-5133 Fax (336) 222-5019
P.O. Box 1358
Burlington, N.C. 27216-1358

CITY OF BURLINGTON NORTH CAROLINA FEB. 14 1893

STEPHEN R. SHOAF
DIRECTOR OF UTILITIES

August 31, 2006

Ms. Connie Brower
North Carolina Department of Environment and Natural Resources
DWQ Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: Proposed Change for Cadmium Freshwater Water Quality Standard
2006 Triennial Review

Dear Ms. Brower:

I am the Pretreatment Coordinator for the City of Burlington and I am writing to oppose the proposed change in the freshwater water quality standard for cadmium. The proposed change from 2 ppb to 0.16 ppb will impact our City dramatically.

There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium down to 0.16 ug/l, nor am I aware of any commercial or municipal laboratory in North Carolina that can measure cadmium to the concentration of the proposed standard. Even the State DWQ laboratory does not have the capability to measure to that level. The current acceptable detection limit for most EPA approved methods for cadmium is 2.0 ug/l.

Wastewater treatment plants located on very low flow streams in North Carolina typically receive the state water quality standard as an NPDES permit limit since there is no dilution factor. If the water quality standard is changed to 0.16 ppb, that limit will be placed in the NPDES permits of plants on low flow streams. The municipality is in the very uncomfortable legal position of being asked by DWQ to accept an NPDES permit limit that the municipality cannot verify they are capable of achieving.

Regardless of whether a NPDES permit limit is imposed on our POTW and regardless of whether that value can be measured in a laboratory, the DWQ Pretreatment Unit requires the use of the water quality standard when calculating a Maximum Allowable Headworks Loading [MAHL] for cadmium. A "Maximum Allowable Headworks Loading" calculation results in the amount of cadmium that can be permitted to enter the treatment plant and still mathematically and theoretically have the plant effluent meet the water quality standard.

The City of Burlington's Maximum Allowable Headworks Loading for cadmium using the current 2.0 ug/l North Carolina water quality standard is 0.4670 pounds for the South

Burlington WWTP and 1.3809 pounds for the East Burlington WWTP. Using the proposed water quality standard of 0.16 ug/l results in a Maximum Allowable Headworks Loading of 0.0374 pounds for the South Plant and 0.0931 pounds for the East Burlington Plant. Therefore, the new standard will result in an **immediate over allocation scenario** for cadmium at our South Burlington plant. The East Burlington WWTP would be very close to over allocation as well.

Current DWQ Pretreatment Unit policy prohibits over allocation of any pollutant and requires immediate resolution of the over allocation situation. In the instance where domestic sources alone cause an over allocation, there is absolutely no cadmium capacity for industrial users. No industrial user would be allowed to discharge a detectable level of cadmium at any time. *Of equal importance, no new industrial dischargers with detectable levels of cadmium could locate in any city with cadmium over allocation.* The North Carolina Department of Commerce will not be able to recruit new industry to North Carolina if the industrial wastewater contains detectable amounts of cadmium, because this new standard will be statewide and many wastewater treatment plants will have no cadmium allocation to give.

There are many sources of the cadmium found in domestic wastewater. Common foods have naturally occurring amounts of cadmium. Products like refined foods, coffee, tea and seafood, particularly crustaceans and shellfish, are all definite sources of cadmium. Soil levels of cadmium are increased by cadmium in the air and by high–phosphate fertilizers and this can enter the food chain through ingested crops. Therefore, even municipalities that receive predominantly domestic wastewater may be impacted negatively if the proposed standard is adopted. Over allocation would still have to be addressed and potentially a moratorium could be issued by DWQ for domestic connections as well.

A review of historical industrial user data for cadmium in North Carolina cities has shown trace/detectable levels of cadmium in the wastewater discharges from the following categories of industries:

Soft Drink Manufacturer	Meat Packers	Potato Chip Manufacturer
Personal Care/Personal Hygiene Products	Industrial/Commercial Laundries	Bread/Bakery Product Manufacturing
Pharmaceutical Manufacturing Facilities	Circuit Board Manufacturing Facility	Electrical and Electronic Components Manufacturing Facility
Centralized Waste Treatment Facilities	Transportation Equipment Cleaning Facilities	Metal Finishing Facilities
Electroplating Facilities	Textile Facilities	Photofinishing Facilities
Metal Products and Machinery Facilities	Organic Chemical Manufacturing Facilities	Inorganic Chemical Manufacturing Facilities
Chemical Repackaging Facilities	Tire Manufacturing Facilities	Printing and Publishing Facilities

Many of these facilities will not be able to control the trace levels of cadmium and if we must enforce the new water quality standard and resulting cadmium MAHLs and local limits, theses facilities will have no choice but to shut down, particularly all of the metal finishing facilities, even those that do not plate cadmium.

Both City of Burlington wastewater treatment plants rarely have detectable levels of cadmium at the influent of the treatment plant. Our NPDES permit currently requires at least quarterly Whole Effluent Toxicity testing conducted using POTW effluent concentrations equal to 7Q10 conditions in the receiving stream (7 day lowest flow in a 10 year period). The results of our tests routinely show "No Observable Acute or Chronic Effect" at these low flow conditions.

Considering the sources of cadmium, a more effective approach to protecting aquatic systems and the environment in general would be an effective material recycling program. Much of the cadmium entering the environment is from materials that could be recycled (batteries, tires, plastics) and this would be easier than trying to remove trace amounts in the wastewater. Furthermore, the mandatory use of alternative fuels should be considered in cars, trucks, and airplanes. Coal and other fossil fuels contain cadmium, and their combustion releases this element in emissions to the atmosphere, which ultimately ends up in our waters and soil.

The North Carolina Pretreatment Consortium will present detailed information concerning issues with the EPA study upon which the proposed standard is based. The decision on the proposed change in the cadmium water quality standard should be delayed until the issues raised can be addressed and the impacts on North Carolina pretreatment programs, NPDES permits, and economic development can be assessed.

We appreciate the opportunity to comment on this very important topic.

Sincerely,

Stephen R. Shoaf
Director of Utilities
City of Burlington

City of Clinton
Department of Public Works and Utilities
Norman H. Larkins WPCF

Post Office Box 199
Clinton, North Carolina 28329-0199
Telephone (910) 299-4908
Fax (910) 590-2387

Chris Doherty
Director of Public Works and Utilities

Neil Carroll
Water Resources Superintendent

Regina Fortune
Environmental Programs Manager

September 1, 2006

Ms. Connie Brower [connie.brower@ncmail.net]
North Carolina Department of Environment and Natural Resources
DWQ Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: Proposed Change for Cadmium Freshwater Water Quality Standard
2006 Triennial Review

Dear Ms. Brower,

I am the Environmental Programs Manager for the City of Clinton and I am writing to oppose the proposed change in the freshwater water quality standard for cadmium. The proposed change from 2 ppb to 0.16 ppb will impact our City dramatically.

The City of Clinton Pretreatment Program Information is as follows:

- Population Served: 9500
- Number of POTWs: 1
- Total Permitted Capacity: 5.0 MGD
- Number of Significant Industrial Users: 6 currently, 1 being added this year

There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium down to 0.16 ug/l, nor am I aware of any commercial or municipal laboratory in North Carolina that can measure cadmium to the concentration of the proposed standard. Even the State DWQ laboratory does not have the capability to measure to that level. The current acceptable detection limit for most EPA approved methods for cadmium is 2.0 ug/l.

Wastewater treatment plants located on very low flow streams in North Carolina typically receive the state water quality standard as an NPDES permit limit since there is no dilution factor. If the water quality standard is changed to 0.16 ppb, that limit will be placed in the NPDES permits of plants on low flow streams. The municipality is in the very uncomfortable legal position of being asked by DWQ to accept an NPDES permit limit that the municipality cannot verify they are capable of achieving.

Regardless of whether a NPDES permit limit is imposed on our POTW and regardless of whether that value can be measured in a laboratory, the DWQ Pretreatment Unit requires the use of the water quality standard when calculating a Maximum Allowable Headworks Loading [MAHL] for cadmium. A "Maximum Allowable Headworks Loading" calculation results in the amount of cadmium that can be permitted to enter the treatment plant and still mathematically and theoretically have the plant effluent meet the water quality standard.

The City of Clinton Maximum Allowable Headworks Loading for cadmium using the current 2.0 ug/l North Carolina water quality standard is 0.1278 pounds. Using the proposed water quality standard of 0.16 ug/l results in a Maximum Allowable Headworks Loading of 0.0102 pounds. The calculated cadmium loading from domestic sources alone is 0.0054 pounds. Two industries are currently allocated for Cadmium and their contribution is 0.0550 pounds. Therefore, the new standard will result in an immediate overallocation scenario for cadmium at our plant.

Current DWQ Pretreatment Unit policy prohibits over allocation of any pollutant and requires immediate resolution of the over allocation situation. In the instance where domestic sources alone cause an over allocation, there is absolutely no cadmium capacity for industrial users. No industrial user would be allowed to discharge a detectable level of cadmium at any time. *Of equal importance, no new industrial dischargers with detectable levels of cadmium could locate in any city with cadmium over allocation.* The North Carolina Department of Commerce will not be able to recruit any new industry to North Carolina if the industrial wastewater contains detectable amounts of cadmium, because this new standard will be statewide and many wastewater treatment plants will have no cadmium allocation to give.

Since domestic wastewater often contains detectable levels of cadmium, even municipalities that receive predominantly domestic wastewater may be impacted negatively if the proposed standard is adopted. Over allocation would still have to be addressed and potentially a moratorium could be issued by DWQ for domestic connections as well.

A review of historical industrial user data for cadmium in North Carolina cities has shown trace/detectable levels of cadmium in the wastewater discharges from the following categories of industries:

Soft Drink Manufacturer	Meat Packers	Potato Chip Manufacturer
Personal Care/Personal Hygiene Products	Industrial/Commercial Laundries	Bread/Bakery Product Manufacturing
Pharmaceutical Manufacturing Facilities	Circuit Board Manufacturing Facility	Electrical and Electronic Components Manufacturing Facility
Centralized Waste Treatment Facilities	Transportation Equipment Cleaning Facilities	Metal Finishing Facilities
Electroplating Facilities	Textile Facilities	Photofinishing Facilities
Metal Products and Machinery Facilities	Organic Chemical Manufacturing Facilities	Inorganic Chemical Manufacturing Facilities
Chemical Repackaging Facilities	Tire Manufacturing Facilities	Printing and Publishing Facilities

The City of Clinton has recorded detectable levels of cadmium in the following industrial categories:

- Commercial laundry
- Industrial laundry
- Metal forming facility
- Speaker cone manufacturing facility

Many of these facilities will not be able to control the trace levels of cadmium and if we must enforce the new water quality standard and resulting cadmium MAHLs and local limits, these facilities will have no choice but to shut down, particularly all of the metal finishing facilities, even those that do not plate cadmium.

Our POTW occasionally has detectable levels of cadmium at the influent of the treatment plant. Our NPDES permit currently requires at least quarterly Whole Effluent Toxicity testing conducted using POTW effluent concentrations equal to 7Q10 conditions in the receiving stream (7 day lowest flow in a 10 year period) which is 100% in our case as we have no dilution factor in our receiving stream. The results of our tests routinely show "No Observable Acute or Chronic Effect" at these low flow conditions.

The North Carolina Pretreatment Consortium will present detailed information concerning issues with the EPA study upon which the proposed standard is based. The decision on the proposed change in the cadmium water quality standard should be delayed until the issues raised can be addressed and the impacts on North Carolina pretreatment programs, NPDES permits, and economic development can be assessed.

We appreciate the opportunity to comment on this very important topic.

Sincerely,

Regina H. Fortune

Regina H. Fortune
Environmental Programs Manager
City of Clinton

City of Graham
P. O. Drawer 357
201 South Main Street
Graham, North Carolina 27253
Tel: (336) 570-6700 / Fax: (336) 570-6703

August 30, 2006

Ms. Connie Brower [connie.brower@ncmail.net]
North Carolina Department of Environment and Natural Resources
DWQ Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: Proposed Change for Cadmium Freshwater Water Quality Standard
2006 Triennial Review

Dear Ms. Brower,

I am the Pretreatment Coordinator for the City of Graham and I am writing to oppose the proposed change in the freshwater water quality standard for cadmium. The proposed change from 2 ppb to 0.16 ppb will impact our City dramatically.

The City of Graham Pretreatment Program information is as follows:

- Population Served: 13,776
- Number of POTWs: 1
- Total Permitted Capacity: 3.5 MGD
- Number of Significant Industrial Users: 5

There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium down to 0.16 ug/l, nor am I aware of any commercial or municipal laboratory in North Carolina that can measure cadmium to the concentration of the proposed standard. Even the State DWQ laboratory does not have the capability to measure to that level. The current acceptable detection limit for most EPA approved methods for cadmium is 2.0 ug/l.

Wastewater treatment plants located on very low flow streams in North Carolina typically receive the state water quality standard as an NPDES permit limit since there is no dilution factor. If the water quality standard is changed to 0.16 ppb, that limit will be placed in the NPDES permits of plants on low flow streams. The municipality is in the very uncomfortable legal position of being asked by DWQ to accept an NPDES permit limit that the municipality cannot verify they are capable of achieving.

Regardless of whether a NPDES permit limit is imposed on our POTW and regardless of whether that value can be measured in a laboratory, the DWQ Pretreatment Unit requires the use of the water quality standard when calculating a Maximum Allowable Headworks Loading [MAHL] for cadmium. A "Maximum Allowable Headworks Loading" calculation results in the amount of cadmium that can be permitted to enter the treatment plant and still mathematically and theoretically have the plant effluent meet the water quality standard.

The City of Graham Maximum Allowable Headworks Loading for cadmium using the current 2.0 ug/l North Carolina water quality standard is 1.21 pounds. Using the proposed water quality standard of 0.16 ug/l results in a Maximum Allowable Headworks Loading of 0.102 pounds at permitted flow. The calculated cadmium loading from domestic sources alone is 0.029 at permitted flow. The Instream Waste Concentration for the City of Graham is 14% going into the Haw River.

Current DWQ Pretreatment Unit policy prohibits overallocation of any pollutant and requires immediate resolution of the overallocation situation. In the instance where domestic sources alone cause an overallocation, there is absolutely no cadmium capacity for industrial users. No industrial user would be allowed to discharge a detectable level of cadmium at any time. *Of equal importance, no new industrial dischargers with detectable levels of cadmium could locate in any city with cadmium overallocation.* The North Carolina Department of Commerce will not be able to recruit any new industry to North Carolina if the industrial wastewater contains detectable amounts of cadmium, because this new standard will be state-wide and many wastewater treatment plants will have no cadmium allocation to give.

Since domestic wastewater often contains detectable levels of cadmium, even municipalities that receive predominantly domestic wastewater may be impacted negatively if the proposed standard is adopted. Overallocation would still have to be addressed and potentially a moratorium could be issued by DWQ for domestic connections as well.

A review of historical industrial user data for cadmium in North Carolina cities has shown trace/detectable levels of cadmium in the wastewater discharges from the following categories of industries:

Soft Drink Manufacturer	Meat Packers	Potato Chip Manufacturer
Personal Care/Personal Hygiene Products	Industrial/Commercial Laundries	Bread/Bakery Product Manufacturing
Pharmaceutical Manufacturing Facilities	Circuit Board Manufacturing Facility	Electrical and Electronic Components Manufacturing Facility
Centralized Waste	Transportation Equipment	Metal Finishing Facilities

Treatment Facilities	Cleaning Facilities	
Electroplating Facilities	Textile Facilities	Photofinishing Facilities
Metal Products and Machinery Facilities	Organic Chemical Manufacturing Facilities	Inorganic Chemical Manufacturing Facilities
Chemical Repackaging Facilities	Tire Manufacturing Facilities	Printing and Publishing Facilities

The City of Graham has recorded detectable levels of cadmium in the following industrial categories: Industrial Laundry
Medical Waste Incinerator
Truck Wash

Many of these facilities will not be able to control the trace levels of cadmium and if we must enforce the new water quality standard and resulting cadmium MAHLs and local limits, theses facilities will have no choice but to shut down, particularly all of the metal finishing facilities, even those that do not plate cadmium.

Our POTW never has detectable levels of cadmium at the influent of the treatment plant. Our NPDES permit currently requires at least quarterly Whole Effluent Toxicity testing conducted using POTW effluent concentrations equal to 7Q10 conditions in the receiving stream (7 day lowest flow in a 10 year period). The results of our tests routinely show "No Observable Acute or Chronic Effect" at these low flow conditions.

The North Carolina Pretreatment Consortium will present detailed information concerning issues with the EPA study upon which the proposed standard is based. The decision on the proposed change in the cadmium water quality standard should be delayed until the issues raised can be addressed and the impacts on North Carolina pretreatment programs, NPDES permits, and economic development can be assessed.

We appreciate the opportunity to comment on this very important topic.

Sincerely,

Scott Pickard
Pretreatment Coordinator
City of Graham

PUBLIC HEARING COMMENTS
TRIENNIAL REVIEW
JULY 25, 2006 – RALEIGH, NORTH CAROLINA

My name is Victor Quick and I am employed as the Utility Director for the City of Graham. In that capacity, I also serve as the Permittee for the City of Graham's NPDES permit.

However, today I am here speaking as a member of the North Carolina Pretreatment Consortium Incorporated. The North Carolina Pretreatment Consortium, Incorporated is a non-profit organization representing over 140 pretreatment professionals from municipalities throughout the State of North Carolina. Since its inception in 1997, the Pretreatment Consortium has grown to represent 120 of the state's 125 pretreatment programs. North Carolina's pretreatment programs cover 147 municipal wastewater treatment plants with a combined NPDES permitted flow of over 900 MGD, more than 90% of all municipal NPDES permitted flow in the state.

All decisions, good or bad, result in trade-offs and all decisions, good or bad, result in consequences. A <u>good</u> decision is an educated one. To make an educated decision, the trade offs and consequences must be recognized and then examined and weighed.

The North Carolina Pretreatment Consortium appreciates the opportunity to present the trade-offs and consequences of the proposed change in the North Carolina cadmium water quality standard for freshwaters. The proposal would change the current water quality standard of 2 parts per billion (ppb) to 0.16 ppb, over an order of magnitude reduction.

0.16 parts per billion or micrograms per liter (ug/l) equals 160 parts per trillion (ppt). Let's talk about what we will be trying to measure for a moment. One part per trillion is the equivalent of one inch in <u>16 million miles</u>----so the new water quality standard is the equivalent of 160 inches in 16 million miles. (The old water quality standard of 2 ppb was the equivalent of 2 inches in 16,000 miles.)

The Pretreatment Consortium is concerned about the consequences of this change on three fronts: laboratory detection levels, implementation of NPDES permit limits and of course, the implications for the pretreatment programs in North Carolina.

<u>Laboratory Detection Limits</u>

There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium down to 160 parts per trillion, nor am I aware of any commercial or municipal laboratory in North Carolina that can measure cadmium to the concentration of the proposed standard.

The current acceptable lower reporting level for EPA approved methods is 2 parts per billion which is equivalent to the current water quality standard.

For instance, at the City of Graham's wastewater treatment plant, the MAHL or "cadmium pie" using the current 2 ppb water quality standard is 1.21 pounds. Using the proposed water quality standard of 0.16 ppb the "cadmium pie" is reduced to 0.102 pounds, which is only 1.6 ounces for the entire City of Graham serving a population of approximately 14,000 people.

In order not to exceed or overallocate this new cadmium pie, all discharges must be significantly less than the current detection limit of 2 ppb. That might sound simple....we'll just shut down all the cadmium electroplaters. However, an examination of the cadmium levels in other types of industries is very interesting. Some food processors have 2 or 3 ppb in their effluents. The FDA is not alarmed at all with 2 or 3 parts per billion of cadmium. Industrial laundries that just wash uniforms from various work locations have 15 or 16 ppb of cadmium in their wastewater, centralized waste treatment facilities that bring various types of wastewater on-site and pretreat it have detectable levels of cadmium as do virtually all plating operations...even those that do not plate cadmium on site or even have cadmium on site. Cadmium is present at ppb levels in items made of other base metals. All of these facilities will have to be a non-detect in order for a wastewater treatment plant to meet the new cadmium criteria. Most people do not realize it but there are not really any treatment processes that can take cadmium at ppb levels and remove it down to ppt levels. Cadmium pretreatment processes are for much higher concentrations. Yes, it can take 50 ppm down to 0.1 ppm but not parts per billion to parts per trillion.

Many facilities will not be able to control the trace levels of cadmium and if we must enforce the new standards on all fronts theses facilities will have no choice but to shut down, particularly all of the metal finishing facilities, even those that do not plate cadmium.

The North Carolina Department of Commerce will not be able to recruit any new industry to North Carolina if their wastewater contains detectable amounts of cadmium, because this new standard will be state-wide and many wastewater treatment plants will have no cadmium pie to give anyone. And we've already talked about the variety of industries that have had cadmium detects.

If wastewater treatment plants are over allocated just with the domestic sources of cadmium, then the cadmium issue is really no longer a pretreatment issue. Pretreatment programs regulate industrial sources and enforce limits on industrial sources. Households are another matter.

If cadmium must be controlled at the part per trillion level, then the FDA and the EPA and North Carolina DWQ need to consider banning the use of cadmium in certain household products, personal care products and household uses. It is now a product source control issue not a pretreatment issue.

WATER Resources City of Greensboro

September 1, 2006

Ms. Connie Brower [connie.brower@ncmail.net] [Fax: 919-715-5637]
North Carolina Department of Environment and Natural Resources
DWQ Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: Proposed Change for Cadmium Freshwater Water Quality Standard
2006 Triennial Review

Dear Ms. Brower,

I am employed as the Laboratory and Industrial Waste Section Supervisor for the City of Greensboro Water Resources Department. In that capacity, I also serve as the compliance officer for Greensboro's two NPDES permits. I have worked for the City of Greensboro in the wastewater operations, laboratory and pretreatment fields for over 30 years. I am writing to oppose the proposed change in the freshwater water quality standard for cadmium. The proposed change from 2 ppb to 0.16 ppb will impact our City dramatically.

The City of Greensboro Pretreatment Program information is as follows:

- Population Served: ~225,000
- Number of POTWs: 2
- Total Permitted Capacity: 56 MGD
- Number of Significant Industrial Users: 37

The City of Greensboro is concerned about the consequences of this change on three fronts: laboratory detection levels, implementation of NPDES permit limits and the implications for the pretreatment program.

Laboratory Issues

There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium down to 0.16 ug/l, nor am I aware of any commercial or municipal laboratory in North Carolina that can measure cadmium to the concentration of the proposed standard. Even the State DWQ laboratory does not have the capability to measure to that level. The current acceptable detection limit for most EPA approved methods for cadmium is 2.0 ug/l.

NPDES Permit Limits

Both City of Greensboro wastewater treatment plants are located on very low flow receiving streams. Both POTWs typically receive the state water quality standard as an NPDES permit limit if DWQ deems a permit limit necessary for a particular parameter. If the water quality standard is changed to 0.16 ppb, that limit may very well be placed in the Greensboro NPDES permits. This would place Greensboro in the unacceptable legal position of being asked by DWQ to accept an NPDES permit limit that we cannot verify we are capable of achieving.

Certainly, quantitation level language will have to be placed in the permits stating that as long as the plant effluent concentrations are below the lower reporting level of 2 ppb, the plant is considered to be compliant. There is a precedent for this type of permit language for mercury and cyanide. But a decade from now when new laboratory instrumentation is developed to analyze cadmium at part per trillion levels, I predict that both Greensboro POTWs will be in non-compliance and DWQ will say, "You accepted that limit 10 years ago and did not contest it. The time to contest a limit is when it is initially placed in your NPDES permit not during an enforcement action." Since I have been in the field for 30 years, I personally witnessed this happen with mercury in North Carolina.

Being asked to accept a limit that cannot be measured does not allow for due process during the NPDES permit process.

Pretreatment Program Issues

Regardless of whether a NPDES permit limit is imposed on our POTW and regardless of whether that value can be measured in a laboratory, the DWQ Pretreatment Unit requires the use of the water quality standard when calculating a Maximum Allowable Headworks Loading [MAHL] for cadmium. A "Maximum Allowable Headworks Loading" calculation results in the amount of cadmium that can be permitted to enter the treatment plant and still mathematically and theoretically have the plant effluent meet the water quality standard.

For instance, at the smaller City of Greensboro wastewater treatment plant, the MAHL or using the current 2 ppb water quality standard was a little over 2 pounds. Using the proposed water quality standard of 0.16 ppb the MAHL is reduced to approximately 3 ounces…3 ounces for the whole north side of Greensboro serving a population of approximately 80,000 people…..The plant is a 16 MGD plant but only has a flow of about 9.5 MGD and we have already exceeded the 3 ounces….In that situation, DWQ can put a moratorium on our plant and not allow any more discharges that contain cadmium.

Both Greensboro POTWs would be immediately overallocated for cadmium using the proposed cadmium WQS of 0.16 ug/l.

Current DWQ Pretreatment Unit policy prohibits overallocation of any pollutant and requires immediate resolution of the overallocation situation. In the instance where domestic sources alone cause an overallocation, there is absolutely no cadmium capacity for industrial users. No industrial user would be allowed to discharge a detectable level of cadmium at any time. *Of equal importance, no new industrial dischargers with detectable levels of cadmium could locate in any city with cadmium overallocation.* The North Carolina Department of Commerce will not be able to recruit any new industry to North Carolina if the industrial wastewater contains detectable amounts of cadmium, because this new standard will be state-wide and many wastewater treatment plants will have no cadmium allocation to give.

Since domestic wastewater often contains detectable levels of cadmium, even municipalities that receive predominantly domestic wastewater may be impacted negatively if the proposed standard is adopted. Overallocation would still have to be addressed and potentially a moratorium could be issued by DWQ for domestic connections as well.

The USEPA Handbook: Septage Treatment and Disposal (1984 Table 3-5) lists cadmium concentrations in septage as ranging from 0.03 mg/L to 10.8 mg/L. The City of Greensboro currently takes domestic septage from Guilford County homes and has recorded cadmium hits in all samples of septage. We would discontinue taking septage if the proposed cadmium standard of 0.16 ug/l is adopted. Certainly the most environmentally sound disposal option for septage is at a POTW, but Greensboro would have no cadmium to allocate to existing industrial users or to septage.

A review of historical industrial user data for cadmium in North Carolina cities has shown trace/detectable levels of cadmium in the wastewater discharges from the following categories of industries:

Soft Drink Manufacturer	Meat Packers	Potato Chip Manufacturer
Personal Care/Personal Hygiene Products	Industrial/Commercial Laundries	Bread/Bakery Product Manufacturing
Pharmaceutical Manufacturing Facilities	Circuit Board Manufacturing Facility	Electrical and Electronic Components Manufacturing Facility
Centralized Waste Treatment Facilities	Transportation Equipment Cleaning Facilities	Metal Finishing Facilities
Electroplating Facilities	Textile Facilities	Photofinishing Facilities
Metal Products and Machinery Facilities	Organic Chemical Manufacturing Facilities	Inorganic Chemical Manufacturing Facilities
Chemical Repackaging Facilities	Tire Manufacturing Facilities	Printing and Publishing Facilities

The City of Greensboro has recorded detectable levels of cadmium in the following industrial categories: meat packers, commercial laundry, pharmaceutical manufacturing facilities, personal care product manufacturing facilities, centralized waste treatment facilities, transportation equipment cleaning facility, electrical and electronic components manufacturing facility, metal finishing facility, electroplating facilities, textile facilities, organic chemical facilities and inorganic chemical manufacturing facility.

Many of these facilities will not be able to control the trace levels of cadmium and if we must enforce the new water quality standard and resulting cadmium MAHLs and local limits, theses facilities will have no choice but to shut down, particularly all of the metal finishing facilities, even those that do not plate cadmium.

Our POTW occasionally has detectable levels of cadmium at the influent of the treatment plant. Our NPDES permit currently requires at least quarterly Whole Effluent Toxicity testing conducted using POTW effluent concentrations equal to 7Q10 conditions in the receiving stream (7 day lowest flow in a 10 year period). The results of our tests routinely show "No Observable Acute or Chronic Effect" at these low flow conditions. The City of Greensboro even voluntarily conducts these tests using 100% effluent and consistently passes at that concentration at both POTWs.

The North Carolina Pretreatment Consortium will present detailed information concerning issues with the EPA study upon which the proposed standard is based. The decision on the proposed change in the cadmium water quality standard should be delayed until the issues raised can be addressed and the impacts on North Carolina pretreatment programs, NPDES permits, and economic development can be assessed.

There will be significant consequences in North Carolina if the proposed cadmium standard is adopted and the current NPDES permitting policies and Pretreatment section policies remain the same.

Please understand that the City of Greensboro Water Resources Department supports the protection of the surface waters of North Carolina. My staff and the Greensboro Water Resources employees are on the front lines of environmental protection. We are in the trenches (and the sewers!) every day operating water reclamation facilities, regulating industrial discharges to the wastewater treatment plants and monitoring and analyzing environmental samples.

The City of Greensboro appreciates the opportunity to comment on this very important topic. We will be glad to discuss our concerns and participate in any stakeholder group formed to address these issues.

Sincerely,

Martie Groome

Martie Groome
Laboratory and Industrial Waste Section Supervisor
City of Greensboro Water Resources Department

PUBLIC SERVICES DEPARTMENT
INDUSTRIAL PRETREATMENT

HIGH POINT
NORTH CAROLINA'S INTERNATIONAL CITY™

August 31, 2006

CERTIFIED MAIL #7002 1000 0005 2425 4631
RETURN RECEIPT REQUESTED

Ms. Connie Brower
North Carolina Department of Environment and Natural Resources
DWQ Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: Proposed Change for Cadmium Freshwater Water Quality Standard
2006 Triennial Review

Dear Ms. Brower,

I am the Pretreatment Coordinator for the City of High Point and I am writing to oppose the proposed change in the freshwater water quality standard for cadmium. The proposed change from 2 ppb to 0.16 ppb will impact our City dramatically.

The City of High Point Pretreatment Program information is as follows:

- Population Served: 90,522
- Number of POTWs: 2
- Number of Significant Industrial Users: 26
- Total Permitted Capacity: 26 MGD Eastside WWTP
  6.2 MGD Westside WWTP

There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium down to 0.16 ug/l, nor am I aware of any commercial or municipal laboratory in North Carolina that can measure cadmium to the concentration of the proposed standard. Even the State DWQ laboratory does not have the capability to measure to that level. The current acceptable detection limit for most EPA approved methods for cadmium is 2.0 ug/l.

Wastewater treatment plants located on very low flow streams in North Carolina typically receive the state water quality standard as an NPDES permit limit since there is no dilution factor. If the water quality standard is changed to 0.16 ppb, that limit will be placed in the NPDES permits of plants on low flow streams. The municipality is in the very uncomfortable legal position of being asked by DWQ to accept an NPDES permit limit that the municipality cannot verify they are capable of achieving.

City of High Point, P.O. Box 230, High Point, NC 27261 USA
TELEPHONE: 336-883-3410 FAX: 336-883-3109 TDD: 336-883-8517

Regardless of whether a NPDES permit limit is imposed on our POTW and regardless of whether that value can be measured in a laboratory, the DWQ Pretreatment Unit requires the use of the water quality standard when calculating a Maximum Allowable Headworks Loading [MAHL] for cadmium. A "Maximum Allowable Headworks Loading" calculation results in the amount of cadmium that can be permitted to enter the treatment plant and still mathematically and theoretically have the plant effluent meet the water quality standard.

The City of High Point Maximum Allowable Headworks Loading for cadmium using the current 2.0 ug/l North Carolina water quality standard is 0.7276 pounds at the Eastside Wastewater Treatment Plant. Using the proposed water quality standard of 0.16 ug/l results in a Maximum Allowable Headworks Loading of 0.0582 pounds. The calculated cadmium loading from domestic sources alone is 0.2690 pounds. Therefore, the new standard will result in an immediate over allocation for cadmium at our Eastside plant.

The City of High Point Maximum Allowable Headworks Loading for cadmium using the current 2.0 ug/l North Carolina water quality standard is 0.2086 pounds at the Westside Wastewater Treatment Plant. Using the proposed water quality standard of 0.16 ug/l results in a Maximum Allowable Headworks Loading of 0.0167 pounds. The calculated cadmium loading from domestic sources alone is 0.0108 pounds. With the Industrial User permits currently issued, the new standard will result in an immediate over allocation for cadmium at our Westside plant.

Current DWQ Pretreatment Unit policy prohibits over allocation of any pollutant and requires immediate resolution of the over allocation situation. In the instance where domestic sources alone cause an over allocation, there is absolutely no cadmium capacity for industrial users. No industrial user would be allowed to discharge a detectable level of cadmium at any time. *Of equal importance, no new industrial dischargers with detectable levels of cadmium could locate in any city with cadmium over allocation.* The North Carolina Department of Commerce will not be able to recruit any new industry to North Carolina if the industrial wastewater contains detectable amounts of cadmium, because this new standard will be state-wide and many wastewater treatment plants will have no cadmium allocation to give.

Since domestic wastewater often contains detectable levels of cadmium, even municipalities that receive predominantly domestic wastewater may be impacted negatively if the proposed standard is adopted. Over allocation would still have to be addressed and potentially a moratorium could be issued by DWQ for domestic connections as well.

A review of historical industrial user data for cadmium in North Carolina cities has shown trace/detectable levels of cadmium in the wastewater discharges from the following categories of industries:

Soft Drink Manufacturer	Meat Packers	Potato Chip Manufacturer
Personal Care/Personal Hygiene Products	Industrial/Commercial Laundries	Bread/Bakery Product Manufacturing
Pharmaceutical Manufacturing Facilities	Circuit Board Manufacturing Facility	Electrical and Electronic Components Manufacturing Facility
Centralized Waste Treatment Facilities	Transportation Equipment Cleaning Facilities	Metal Finishing Facilities
Electroplating Facilities	Textile Facilities	Photofinishing Facilities
Metal Products and Machinery Facilities	Organic Chemical Manufacturing Facilities	Inorganic Chemical Manufacturing Facilities
Chemical Repackaging Facilities	Tire Manufacturing Facilities	Printing and Publishing Facilities

The City of High Point has recorded detectable levels of cadmium in the following industrial categories: Metal Finishing and Organic Chemical Manufacturing

Many of these facilities will not be able to control the trace levels of cadmium and if we must enforce the new water quality standard and resulting cadmium MAHLs and local limits, theses facilities will have no choice but to shut down, particularly all of the metal finishing facilities, even those that do not plate cadmium.

Our POTW never has detectable levels of cadmium at the influent of the treatment plant. Our NPDES permit currently requires at least quarterly Whole Effluent Toxicity testing conducted using POTW effluent concentrations equal to 7Q10 conditions in the receiving stream (7 day lowest flow in a 10 year period). The results of our tests routinely show "No Observable Acute or Chronic Effect" at these low flow conditions.

The North Carolina Pretreatment Consortium will present detailed information concerning issues with the EPA study upon which the proposed standard is based. The decision on the proposed change in the cadmium water quality standard should be delayed until the issues raised can be addressed and the impacts on North Carolina pretreatment programs, NPDES permits, and economic development can be assessed.

We appreciate the opportunity to comment on this very important topic.

Sincerely,

Frank Skee
Industrial Pretreatment Coordinator

William Frazier
Water Quality Lab and Pretreatment Supervisor

A-185

City of Kinston

Department of Public Services

Building & Grounds|Electric|Engineering|Fleet Maintenance|
Solid Waste|Streets|Vector Control|Water & Wastewater

August 30, 2006

Ms. Connie Brower [connie.brower@ncmail.net]
North Carolina Department of Environment and Natural Resources
DWQ Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: Proposed Change for Cadmium Freshwater Water Quality Standard
2006 Triennial Review

Dear Ms. Brower:

I am the Pretreatment Coordinator for the City of Kinston and I am writing to oppose the proposed change in the freshwater water quality standard for cadmium. The proposed change from 2 ppb to 0.16 ppb will impact our City dramatically.

The City of Kinston's Pretreatment Program information is as follows:

- Population Served: 24000
- Number of POTWs: 1
- Total Permitted Capacity: 11.85 MGD
- Number of Significant Industrial Users: 9

There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium down to 0.16 ug/l, nor am I aware of any commercial or municipal laboratory in North Carolina that can measure cadmium to the concentration of the proposed standard. Even the State DWQ laboratory does not have the capability to measure to that level. The current acceptable detection limit for most EPA approved methods for cadmium is 2.0 ug/l.

Wastewater treatment plants located on very low flow streams in North Carolina typically receive the state water quality standard as an NPDES permit limit since there is no dilution factor. If the water quality standard is changed to 0.16 ppb, that limit will be placed in the NPDES permits of plants on low flow streams. The municipality is in the very uncomfortable legal position of being asked by DWQ to accept an NPDES permit limit that the municipality cannot verify they are capable of achieving.

Regardless of whether a NPDES permit limit is imposed on our POTW and regardless of whether that value can be measured in a laboratory, the DWQ Pretreatment Unit requires the use

P O Box 339 Kinston, NC 28502 Phone (252) 939-3306 Fax (252) 939-3741

of the water quality standard when calculating a Maximum Allowable Headworks Loading A-186 [MAHL] for cadmium. A "Maximum Allowable Headworks Loading" calculation results in the amount of cadmium that can be permitted to enter the treatment plant and still mathematically and theoretically have the plant effluent meet the water quality standard.

The City of Kinston's Maximum Allowable Headworks Loading for cadmium using the current 2.0 ug/l North Carolina water quality standard is 1.4809 pounds. Using the proposed water quality standard of 0.16 ug/l results in a Maximum Allowable Headworks Loading of .7622 pounds.

Current DWQ Pretreatment Unit policy prohibits overallocation of any pollutant and requires immediate resolution of the overallocation situation. In the instance where domestic sources alone cause an overallocation, there is absolutely no cadmium capacity for industrial users. No industrial user would be allowed to discharge a detectable level of cadmium at any time. *Of equal importance, no new industrial dischargers with detectable levels of cadmium could locate in any city with cadmium overallocation.* The North Carolina Department of Commerce will not be able to recruit any new industry to North Carolina if the industrial wastewater contains detectable amounts of cadmium, because this new standard will be state-wide and many wastewater treatment plants will have no cadmium allocation to give.

Since domestic wastewater often contains detectable levels of cadmium, even municipalities that receive predominantly domestic wastewater may be impacted negatively if the proposed standard is adopted. Overallocation would still have to be addressed and potentially a moratorium could be issued by DWQ for domestic connections as well.

A review of historical industrial user data for cadmium in North Carolina cities has shown trace/detectable levels of cadmium in the wastewater discharges from the following categories of industries:

Soft Drink Manufacturer	Meat Packers	Potato Chip Manufacturer
Personal Care/Personal Hygiene Products	Industrial/Commercial Laundries	Bread/Bakery Product Manufacturing
Pharmaceutical Manufacturing Facilities	Circuit Board Manufacturing Facility	Electrical and Electronic Components Manufacturing Facility
Centralized Waste Treatment Facilities	Transportation Equipment Cleaning Facilities	Metal Finishing Facilities
Electroplating Facilities	Textile Facilities	Photofinishing Facilities
Metal Products and Machinery Facilities	Organic Chemical Manufacturing Facilities	Inorganic Chemical Manufacturing Facilities
Chemical Repackaging Facilities	Tire Manufacturing Facilities	Printing and Publishing Facilities

The City of Kinston has recorded detectable levels of cadmium in the following industrial category: Metal Finishing Facilities

Many of these facilities will not be able to control the trace levels of cadmium and if we must enforce the new water quality standard and resulting cadmium MAHLs and local limits, theses facilities will have no choice but to shut down, particularly all of the metal finishing facilities, even those that do not plate cadmium.

Our POTW never has detectable levels of cadmium at the influent of the treatment plant. Our NPDES permit currently requires at least quarterly Whole Effluent Toxicity testing conducted using POTW effluent concentrations equal to 7Q10 conditions in the receiving stream (7 day lowest flow in a 10 year period). The results of our tests routinely show "No Observable Acute or Chronic Effect" at these low flow conditions.

The North Carolina Pretreatment Consortium will present detailed information concerning issues with the EPA study upon which the proposed standard is based. The decision on the proposed change in the cadmium water quality standard should be delayed until the issues raised can be addressed and the impacts on North Carolina pretreatment programs, NPDES permits, and economic development can be assessed.

We appreciate the opportunity to comment on this very important topic.

Sincerely,

Kenneth R. Stevens, Jr.
Industrial Pretreatment Coordinator
City of Kinston

P O Box 339 Kinston, NC 28502 Phone (252) 939-3306 Fax (252) 939-3741

A-188

City of Mebane

106 E. Washington Street
Mebane, N.C. 27302
(919) 563-5901

August 30, 2006

Faxed to:
Ms. Connie Brower
DWQ Planning Section
Fax 919-715-5637

RE: Changing the Cadmium Freshwater Water Quality Standard
2006 Triennial Review

Dear Ms. Brower:

This letter is in regard to the proposed change in the freshwater water quality standard for cadmium from 2 ppb to 0.16 ppb. Our treatment plant is permitted for 2.5 MGD and serves six Significant Industrial Users. Of these six, five are permitted under 40 CFR 433 - metal finishing.

The EPA does not currently have an approved wastewater analytical method listed under 40 CFR Part 136 that can measure cadmium down to 0.16 ug/l (ppb). The commercial laboratory that does metals analysis for our POTW cannot measure that low and I do not know of any commercial laboratory that can. The NC DWQ laboratory also does not have that capability. The current acceptable detection limit for our contract laboratory and for most EPA approved methods for cadmium is 2.0 ug/l.

Since our wastewater treatment plant discharges to a very low flow stream, if we receive a NPDES permit limit for cadmium it will be the water quality standard. If the water quality standard is changed to 0.16 ppb, then that will be our limit. We will be asked by DWQ to accept an NPDES permit limit that we can't verify.

Even if we do not receive an NPDES permit and even if we can't measure that low in the laboratory, we are still required to enter the water quality standard into our headworks analysis used to calculate the Maximum Allowable Headworks Loadings (MAHL). The headworks analysis tells us how much loading we have from domestic sources and how much is left over for industry. A MAHL for cadmium tells how much can enter the treatment plant without violating the water quality standard. The DWQ PERCS Pretreatment Group requires that ½ the detection limit be entered into the headworks where analyses are below detection as is the case with our influent and effluent cadmium values.

City of Mebane Comments on Changing the Cadmium Water Quality Standard
Page 2

The City of Mebane Maximum Allowable Headworks Loading for cadmium using the current 2.0 ug/l North Carolina water quality standard is 0.0595 pounds with 80% of the MAHL still available. Using the proposed water quality standard of 0.16 ug/l results in a Maximum Allowable Headworks Loading of 0.0041 pounds. The calculated cadmium loading from domestic sources alone is 0.0081 pounds. Therefore, the new standard will result in an immediate overallocation for cadmium of 0.0041 pounds just from domestic sources.

Since the DWQ Pretreatment Unit does not allow overallocation of any pollutant, this means that we could not make any additional domestic connections. It also means that we would have absolutely no cadmium capacity for industrial users. No industry would be able to discharge detectible cadmium at any time. To make matters even worse this situation would be occurring at a POTW that is at less than half of the NPDES permitted capacity. Since our situation would not be unique, growth and industrial recruitment in North Carolina would be impossible in many areas and greatly limited in others.

Since domestic wastewater often contains detectable levels of cadmium, even municipalities that receive predominantly domestic wastewater could be affected by the proposed standard. Overallocation could result in a moratium on domestic connections.

Cadmium is often present in trace amounts in many industries. Historical industrial user data in North Carolina shows even food and pharmaceutical industries often have detectible amounts of cadmium in their wastewater discharges. Many industrial facilities will not be able to control the trace levels of cadmium and if we must enforce the new water quality standard and resulting cadmium MAHLs and local limits, theses facilities will have no choice but to shut down, particularly metal finishing facilities of which Mebane has five.

The North Carolina Pretreatment Consortium has detailed information concerning issues with the EPA study upon which the proposed standard is based. The decision on the proposed change in the cadmium water quality standard should be postponed until the issues raised and the impacts on North Carolina can be assessed.

Thank you for allowing me to comment extremely important and far reaching proposal.

Sincerely,

Linda Holt

Linda Holt
Pretreatment Coordinator
City of Mebane

CITY OF MONROE

A-190

CITY HALL
300 W. Crowell Street -28110
P.O. Box 69, Monroe, NC 28111-0069
PHONE 704.282.4511 • FAX 704.283.9098

OPERATIONS CENTER
2401 Walkup Avenue - 28110
P.O. Box 69, Monroe NC 28111-0069
PHONE 704.282.4600 • FAX 704.283.6492

August 31, 2006

Ms. Connie Brower
North Carolina Department of Environment and Natural Resources
DWQ Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: Proposed Change for Cadmium Freshwater Water Quality Standard
2006 Triennial Review

Dear Ms. Brower:

I am writing to oppose the proposed change in the freshwater water quality standard for Cadmium. The proposed change from 2µg/l to 0.16 µg/l will have a negative impact on our City.

The City of Monroe Pretreatment Program information is as follows:

- 1 Wastewater Treatment Plant
- Permitted capacity of 10.4 MGD
- 12 Significant Industrial Users

Wastewater Treatment Plants discharging into low flow streams in North Carolina may receive the state water quality standard as an NPDES permit limit. If the water quality standard is changed to 0.16 µg/l that limit may be placed in the NPDES permits of plants on low flow streams. Our Municipality may be asked by DWQ to accept a NPDES permit limit that the municipality cannot verify we are capable of achieving.

Regardless of whether a NPDES limit is imposed on our treatment plant, the DWQ Pretreatment Unit requires the use of the water quality standard when calculating a Maximum Allowable Headworks Loading (MAHL) for cadmium. A MAHL calculation results in the amount of cadmium that can be allowed to enter the treatment plant and still mathematically and theoretically have the plant effluent meet the water quality standard.

The City of Monroe MAHL for cadmium using the current 2µg/l North Carolina water quality standard is 0.3687 lbs/day. Using the proposed water quality standard of 0.16 µg/l results in a MAHL of 0.0295 lbs/day. The calculated cadmium loading from uncontrolled sources alone is

0.0916 lbs/day. Therefore, the new standard will result in an immediate over allocation scenario for cadmium for our plant.

Current DWQ Pretreatment Unit policy prohibits over allocation of any pollutant and requires immediate resolution of the over allocation situation. In the instance where domestic sources alone cause an over allocation, there is no cadmium capacity for industrial users. No industrial user would be allowed to discharge a detectable level of cadmium at any time. Over allocation would still have to be addressed and potentially a moratorium could be issued by DWQ for domestic connections.

The decision on the proposed change in the cadmium water quality standard should be delayed until the issues raised can be addressed and the impacts on North Carolina pretreatment programs, NPDES permits, and economic development can be assessed.

We thank you for the opportunity to comment on this important topic. Should you require additional information please do not hesitate to call me at (704)-282-4632.

Respectfully,

Kim A. Hinson

Kim A. Hinson
WWTP Superintendent

c: WWTP/IUP file
Mr. Russell Colbath
S2-NCDENR Pretreatment Correspondence

CITY OF MONROE

A-192

CITY HALL
300 W. Crowell Street -28110
P.O. Box 69, Monroe, NC 28111-0069
PHONE 704.282.4511 • FAX 704.283.9098

OPERATIONS CENTER
2401 Walkup Avenue - 28110
P.O. Box 69, Monroe NC 28111-0069
PHONE 704.282.4600 • FAX 704.283.6492

August 31, 2006

Ms. Connie Brower
North Carolina Department of Environment and Natural Resources
DWQ Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: Proposed Change for Cadmium Freshwater Water Quality Standard
2006 Triennial Review

Dear Ms. Brower:

I am writing to oppose the proposed change in the freshwater water quality standard for Cadmium. The proposed change from 2μg/l to 0.16 μg/l will have a negative impact on our City.

The City of Monroe Pretreatment Program information is as follows:

- 1 Wastewater Treatment Plant
- Permitted capacity of 10.4 MGD
- 12 Significant Industrial Users

Wastewater Treatment Plants discharging into low flow streams in North Carolina may receive the state water quality standard as an NPDES permit limit. If the water quality standard is changed to 0.16 μg/l that limit may be placed in the NPDES permits of plants on low flow streams. Our Municipality may be asked by DWQ to accept a NPDES permit limit that the municipality cannot verify we are capable of achieving.

Regardless of whether a NPDES limit is imposed on our treatment plant, the DWQ Pretreatment Unit requires the use of the water quality standard when calculating a Maximum Allowable Headworks Loading (MAHL) for cadmium. A MAHL calculation results in the amount of cadmium that can be allowed to enter the treatment plant and still mathematically and theoretically have the plant effluent meet the water quality standard.

The City of Monroe MAHL for cadmium using the current 2μg/l North Carolina water quality standard is 0.3687 lbs/day. Using the proposed water quality standard of 0.16 μg/l results in a MAHL of 0.0295 lbs/day. The calculated cadmium loading from uncontrolled sources alone is

0.0916 lbs/day. Therefore, the new standard will result in an immediate over allocation scenario for cadmium for our plant.

Current DWQ Pretreatment Unit policy prohibits over allocation of any pollutant and requires immediate resolution of the over allocation situation. In the instance where domestic sources alone cause an over allocation, there is no cadmium capacity for industrial users. No industrial user would be allowed to discharge a detectable level of cadmium at any time. Over allocation would still have to be addressed and potentially a moratorium could be issued by DWQ for domestic connections.

The decision on the proposed change in the cadmium water quality standard should be delayed until the issues raised can be addressed and the impacts on North Carolina pretreatment programs, NPDES permits, and economic development can be assessed.

We thank you for the opportunity to comment on this important topic. Should you require additional information please do not hesitate to call me at (704)-282-4632.

Respectfully,

Kyle Ketchum
Pretreatment Coordinator

c: WWTP/IUP file
Mr. Russell Colbath
S2-NCDENR Pretreatment Correspondence

8/31/06

Ms. Connie Brower [connie.brower@ncmail.net]
North Carolina Department of Environment and Natural Resources
DWQ Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: Proposed Change for Cadmium Freshwater Water Quality Standard
2006 Triennial Review

Dear Ms. Brower,

I am the Pretreatment Coordinator for the City of Newton and I am writing to oppose the proposed change in the freshwater water quality standard for cadmium. The proposed change from 2 ppb to 0.16 ppb will impact our City dramatically.

The City of Newton's Pretreatment Program information is as follows:

- Population Served: 13,000
- Number of POTWs: 1
- Total Permitted Capacity: 5 MGD
- Number of Significant Industrial Users: 6

There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium down to 0.16 ug/l, nor am I aware of any commercial or municipal laboratory in North Carolina that can measure cadmium to the concentration of the proposed standard. Even the State DWQ laboratory does not have the capability to measure to that level. The current acceptable detection limit for most EPA approved methods for cadmium is 2.0 ug/l.

Wastewater treatment plants located on very low flow streams in North Carolina typically receive the state water quality standard as an NPDES permit limit since there is no dilution factor. If the water quality standard is changed to 0.16 ppb, that limit will be placed in the NPDES permits of plants on low flow streams. The municipality is in the very uncomfortable legal position of being asked by DWQ to accept an NPDES permit limit that the municipality cannot verify they are capable of achieving.

Regardless of whether a NPDES permit limit is imposed on our POTW and regardless of whether that value can be measured in a laboratory, the DWQ Pretreatment Unit requires the use of the water quality standard when calculating a Maximum Allowable Headworks Loading [MAHL] for cadmium. A "Maximum Allowable Headworks Loading" calculation results in the amount of cadmium that can be permitted to enter the treatment plant and still mathematically and theoretically have the plant effluent meet the water quality standard.

The City of Newton's Maximum Allowable Headworks Loading for cadmium using the current 2.0 ug/l North Carolina water quality standard is 0.3698 pounds. We currently have over 74% of our MAHL available. Using the proposed water quality standard of 0.16 ug/l results in a Maximum Allowable Headworks Loading of 0.0296 pounds. The calculated cadmium loading from domestic sources alone is 0.0173 pounds. That leaves 0.0123 pounds allowable for industries. The City of Newton currently has 0.0783 pounds allocated to industries. Therefore, the new standard will result in an immediate overallocation scenario for cadmium at our plant.
Current DWQ Pretreatment Unit policy prohibits overallocation of any pollutant and requires immediate resolution of the overallocation situation. In the instance where domestic sources alone cause an overallocation, there is absolutely no cadmium capacity for industrial users. No industrial user would be allowed to discharge a detectable level of cadmium at any time. *Of equal importance, no new industrial dischargers with detectable levels of cadmium could locate in any city with cadmium overallocation.* The North Carolina Department of Commerce will not be able to recruit any new industry to North Carolina if the industrial wastewater contains detectable amounts of cadmium, because this new standard will be state-wide and many wastewater treatment plants will have no cadmium allocation to give.

Since domestic wastewater often contains detectable levels of cadmium, even municipalities that receive predominantly domestic wastewater may be impacted negatively if the proposed standard is adopted. Overallocation would still have to be addressed and potentially a moratorium could be issued by DWQ for domestic connections as well.

A review of historical industrial user data for cadmium in North Carolina cities has shown trace/detectable levels of cadmium in the wastewater discharges from the following categories of industries:

Soft Drink Manufacturer	Meat Packers	Potato Chip Manufacturer
Personal Care/Personal Hygiene Products	Industrial/Commercial Laundries	Bread/Bakery Product Manufacturing
Pharmaceutical Manufacturing Facilities	Circuit Board Manufacturing Facility	Electrical and Electronic Components Manufacturing Facility
Centralized Waste Treatment Facilities	Transportation Equipment Cleaning Facilities	Metal Finishing Facilities
Electroplating Facilities	Textile Facilities	Photofinishing Facilities
Metal Products and Machinery Facilities	Organic Chemical Manufacturing Facilities	Inorganic Chemical Manufacturing Facilities
Chemical Repackaging Facilities	Tire Manufacturing Facilities	Printing and Publishing Facilities

The City of Newton has recorded detectable levels of cadmium in the following industrial categories: Textile Mills, Cable Manufacturer, Metal Finishing, Electroplating, and Composting Facility.

Many of these facilities will not be able to control the trace levels of cadmium and if we must enforce the new water quality standard and resulting cadmium MAHLs and local limits, theses facilities will have no choice but to shut down, particularly all of the metal finishing facilities, even those that do not plate cadmium.

Our POTW rarely has detectable levels of cadmium at the influent of the treatment plant. Our NPDES permit currently requires at least quarterly Whole Effluent Toxicity testing conducted using POTW effluent concentrations equal to 7Q10 conditions in the receiving stream (7 day lowest flow in a 10 year period). The results of our tests routinely show "No Observable Acute or Chronic Effect" at these low flow conditions.

The North Carolina Pretreatment Consortium will present detailed information concerning issues with the EPA study upon which the proposed standard is based. The decision on the proposed change in the cadmium water quality standard should be delayed until the issues raised can be addressed and the impacts on North Carolina pretreatment programs, NPDES permits, and economic development can be assessed.

We appreciate the opportunity to comment on this very important topic.

Sincerely,

James Rumley

James Rumley
Pretreatment Coordinator
City of Newton

CITY OF RANDLEMAN
101 Hilliary Street
Randleman, North Carolina 27317
(336) 495-7500 / Fax: (336) 495-7503
www.randleman.org/
ANTHONY V. LOWE, MAYOR

ALDERMEN
Melissa Blalock, Mayor Pro-Tempore
Bud Talley
Charles Byerly
Sherrill Shaw
Phil Pendry

Tony Sears, City Manager

August 30, 2006

Ms. Connie Brower [connie.brower@ncmail.net]
North Carolina Department of Environment and Natural Resources
DWQ Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: Proposed Change for Cadmium Freshwater Water Quality Standard
2006 Triennial Review

Dear Ms. Brower,

I am the Pretreatment Coordinator for the City of Randleman and I am writing to oppose the proposed change in the freshwater water quality standard for cadmium. The proposed change from 2 ppb to 0.16 ppb will impact our City dramatically.

The City of Randleman Pretreatment Program information is as follows:

- Population Served: 3,899
- Number of POTWs: 1
- Total Permitted Capacity: 1.75 MGD
- Number of Significant Industrial Users: 2

There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium down to 0.16 ug/l, nor am I aware of any commercial or municipal laboratory in North Carolina that can measure cadmium to the concentration of the proposed standard. Even the State DWQ laboratory does not have the capability to measure to that level. The current acceptable detection limit for most EPA approved methods for cadmium is 2.0 ug/l.

Wastewater treatment plants located on very low flow streams in North Carolina typically receive the state water quality standard as an NPDES permit limit since there is no dilution factor. If the water quality standard is changed to 0.16 ppb, that limit will be placed in the NPDES permits of plants on low flow streams. The municipality is in the very uncomfortable legal position of being asked by DWQ to accept an NPDES permit limit that the municipality cannot verify they are capable of achieving.

Regardless of whether a NPDES permit limit is imposed on our POTW and regardless of whether that value can be measured in a laboratory, the DWQ Pretreatment Unit requires the use of the water quality standard when calculating a Maximum Allowable Headworks Loading [MAHL] for cadmium. A "Maximum Allowable Headworks Loading" calculation results in the amount of cadmium that can be permitted to enter the treatment plant and still mathematically and theoretically have the plant effluent meet the water quality standard.

The City of Randleman Maximum Allowable Headworks Loading for cadmium using the current 2.0 ug/l North Carolina water quality standard is 0.0973 pounds. Using the proposed water quality standard of 0.16 ug/l results in a Maximum Allowable Headworks Loading of 0.0171 pounds. The calculated cadmium loading from domestic sources alone is 0.0068 pounds.

Current DWQ Pretreatment Unit policy prohibits overallocation of any pollutant and requires immediate resolution of the overallocation situation. In the instance where domestic sources alone cause an overallocation, there is absolutely no cadmium capacity for industrial users. No industrial user would be allowed to discharge a detectable level of cadmium at any time. *Of equal importance, no new industrial dischargers with detectable levels of cadmium could locate in any city with cadmium overallocation.* The North Carolina Department of Commerce will not be able to recruit any new industry to North Carolina if the industrial wastewater contains detectable amounts of cadmium, because this new standard will be state-wide and many wastewater treatment plants will have no cadmium allocation to give.

Since domestic wastewater often contains detectable levels of cadmium, even municipalities that receive predominantly domestic wastewater may be impacted negatively if the proposed standard is adopted. Overallocation would still have to be addressed and potentially a moratorium could be issued by DWQ for domestic connections as well.

A review of historical industrial user data for cadmium in North Carolina cities has shown trace/detectable levels of cadmium in the wastewater discharges from the following categories of industries:

Soft Drink Manufacturer	Meat Packers	Potato Chip Manufacturer
Personal Care/Personal Hygiene Products	Industrial/Commercial Laundries	Bread/Bakery Product Manufacturing
Pharmaceutical Manufacturing Facilities	Circuit Board Manufacturing Facility	Electrical and Electronic Components Manufacturing Facility
Centralized Waste Treatment Facilities	Transportation Equipment Cleaning Facilities	Metal Finishing Facilities
Electroplating Facilities	Textile Facilities	Photofinishing Facilities
Metal Products and Machinery Facilities	Organic Chemical Manufacturing Facilities	Inorganic Chemical Manufacturing Facilities
Chemical Repackaging Facilities	Tire Manufacturing Facilities	Printing and Publishing Facilities

The City of Randleman has recorded detectable levels of cadmium in the following industrial categories: Textile Dyeing and Finishing.

Many of these facilities will not be able to control the trace levels of cadmium and if we must enforce the new water quality standard and resulting cadmium MAHLs and local limits, theses facilities will have no choice but to shut down, particularly all of the metal finishing facilities, even those that do not plate cadmium.

Our POTW rarely has detectable levels of cadmium at the influent of the treatment plant. Our NPDES permit currently requires at least quarterly Whole Effluent Toxicity testing conducted using POTW effluent concentrations equal to 7Q10 conditions in the receiving stream (7 day lowest flow in a 10 year period). The results of our tests routinely show "No Observable Acute or Chronic Effect" at these low flow conditions.

The North Carolina Pretreatment Consortium will present detailed information concerning issues with the EPA study upon which the proposed standard is based. The decision on the proposed change in the cadmium water quality standard should be delayed until the issues raised can be addressed and the impacts on North Carolina pretreatment programs, NPDES permits, and economic development can be assessed.

We appreciate the opportunity to comment on this very important topic.

Sincerely,

Joan P. Wall

Joan P. Wall
Pretreatment Coordinator
City of Randleman

City of Reidsville
A-200
1100 Vance Street, Reidsville, North Carolina 27320
(336) 349-1070 • Fax (336) 634-1738

PUBLIC WORKS DEPARTMENT

August 31, 2006

Ms. Connie Brower
North Carolina Department of Environment and Natural Resources
DWQ Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: Proposed Change for Cadmium Freshwater Water Quality Standard 2006 Triennial Review

Dear Ms. Brower:

I am the Public Works Director for the City of Reidsville and I am writing to oppose the proposed change in the freshwater water quality standard for cadmium. The proposed change from 2 ppb to 0.16 ppb will impact our City dramatically.

The City of Reidsville Pretreatment Program information is as follows:

- Population Served: 14,630
- Number of POTWs: 1
- Total Permitted Capacity: 3.225 MGD
- Number of Significant Industrial Users: 12

There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium down to 0.16 ug/l, nor am I aware of any commercial or municipal laboratory in North Carolina that can measure cadmium to the concentration of the proposed standard. Even the State DWQ laboratory does not have the capability to measure to that level. The current acceptable detection limit for most EPA approved methods for cadmium is 2.0 ug/l.

Wastewater treatment plants located on very low flow streams in North Carolina typically receive the state water quality standard as an NPDES permit limit since there is no dilution factor. If the water quality standard is changed to 0.16 ppb, that limit will be placed in the NPDES permits of plants on low flow streams. The City is in the very uncomfortable legal position of being asked by DWQ to accept an NPDES permit limit that the City cannot verify they are capable of achieving.

Regardless of whether a NPDES permit limit is imposed on our POTW and regardless of whether that value can be measured in a laboratory, the DWQ Pretreatment Unit requires the use of the water quality standard when calculating a Maximum Allowable Headworks

Loading [MAHL] for cadmium. A "Maximum Allowable Headworks Loading" calculation results in the amount of cadmium that can be permitted to enter the treatment plant and still mathematically and theoretically have the plant effluent meet the water quality standard.

The City of Reidsville Wastewater Treatment Plant's Maximum Allowable Headworks Loading for cadmium is currently based on an NPDES Permit limit of 3.3 ug/l and is calculated to be 0.2502 pounds. Using the proposed water quality standard of 0.16 ug/l the Maximum Allowable Headworks Loading would be 0.0204 pounds. This represents a 92% reduction in the Maximum Allowable Headworks Loading. The City of Reidsville has three EPA regulated categorical industries classified as metal finishers which mandate a cadmium limit and four significant industrial users which require a cadmium limit based on their wastewater concentration and loading to the WWTP. Currently the City has allocated 0.1562 pounds of cadmium to the permitted industries. Based on the Maximum Allowable Industrial Loading using the proposed new water quality standard of 0.016 ug/l, the City will be over allocated by 0.1358 pounds or 667%. The City would have to reduce the industrial users permitted cadmium limit by as much as 94%.

Current DWQ Pretreatment Unit policy prohibits overallocation of any pollutant and requires immediate resolution of the overallocation situation. In the instance where domestic sources alone cause an overallocation, there is absolutely no cadmium capacity for industrial users. No industrial user would be allowed to discharge a detectable level of cadmium at any time. *Of equal importance, no new industrial dischargers with detectable levels of cadmium could locate in any city with cadmium overallocation.* The North Carolina Department of Commerce will not be able to recruit any new industry to North Carolina if the industrial wastewater contains detectable amounts of cadmium, because this new standard will be state-wide and many wastewater treatment plants will have no cadmium allocation to give.

Since domestic wastewater often contains detectable levels of cadmium, even municipalities that receive predominantly domestic wastewater may be impacted negatively if the proposed standard is adopted. Overallocation would still have to be addressed and potentially a moratorium could be issued by DWQ for domestic connections as well.

A review of historical industrial user data for cadmium in North Carolina cities has shown trace/detectable levels of cadmium in the wastewater discharges from the following categories of industries:

Soft Drink Manufacturer	Meat Packers	Potato Chip Manufacturer
Personal Care/Personal Hygiene Products	Industrial/Commercial Laundries	Bread/Bakery Product Manufacturing
Pharmaceutical Manufacturing Facilities	Circuit Board Manufacturing Facility	Electrical and Electronic Components Manufacturing Facility
Centralized Waste	Transportation Equipment	Metal Finishing Facilities

Treatment Facilities	Cleaning Facilities	
Electroplating Facilities	Textile Facilities	Photofinishing Facilities
Metal Products and Machinery Facilities	Organic Chemical Manufacturing Facilities	Inorganic Chemical Manufacturing Facilities
Chemical Repackaging Facilities	Tire Manufacturing Facilities	Printing and Publishing Facilities

The City of Reidsville has recorded detectable levels of cadmium in the following industrial categories: Metal Finishers and Plastic recycling.

Many of these facilities will not be able to control the trace levels of cadmium and if we must enforce the new water quality standard and resulting cadmium MAHLs and local limits, theses facilities will have no choice but to shut down, particularly all of the metal finishing facilities, even those that do not plate cadmium.

Our POTW rarely has detectable levels of cadmium at the <u>influent</u> of the treatment plant. Our NPDES permit currently requires at least quarterly Whole Effluent Toxicity testing conducted using POTW effluent concentrations equal to 7Q10 conditions in the receiving stream (7 day lowest flow in a 10 year period). The results of our tests routinely show "No Observable Acute or Chronic Effect" at these low flow conditions.

The North Carolina Pretreatment Consortium will present detailed information concerning issues with the EPA study upon which the proposed standard is based. The decision on the proposed change in the cadmium water quality standard should be delayed until the issues raised can be addressed and the impacts on North Carolina pretreatment programs, NPDES permits, and economic development can be assessed.

We appreciate the opportunity to comment on this very important topic.

Sincerely,

Steven L. Routh,
Public Works Director

Cc: D. Kelly Almond, City Manager
Nadine Blackwell, UWHMS Senior Manager
Mike Burleson, UWHMS ORC

Technical Services Division

ROCKY MOUNT
NORTH CAROLINA

Department of
Water Resources

September 1, 2006

Ms. Connie Brower [connie.brower@ncmail.net]
North Carolina Department of Environment and Natural Resources
DWQ Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: Proposed Change for Cadmium Freshwater Water Quality Standard
2006 Triennial Review

Dear Ms. Brower,

I am the Pretreatment Coordinator for the City of Rocky Mount and I am writing to oppose the proposed change in the freshwater water quality standard for cadmium. The proposed change from 2 ppb to 0.16 ppb will impact our City dramatically.

The City of Rocky Mount Pretreatment Program information is as follows:

- Population Served: 58,000
- Number of POTWs: 1
- Total Permitted Capacity: 21 MGD
- Number of Significant Industrial Users: 12

There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium down to 0.16 ug/l, nor am I aware of any commercial or municipal laboratory in North Carolina that can measure cadmium to the concentration of the proposed standard. Even the State DWQ laboratory does not have the capability to measure to that level. The current acceptable detection limit for most EPA approved methods for cadmium is 2.0 ug/l.

Wastewater treatment plants located on very low flow streams in North Carolina typically receive the state water quality standard as an NPDES permit limit since there is no dilution factor. If the water quality standard is changed to 0.16 ppb, that limit will be placed in the NPDES permits of plants on low flow streams. The municipality is in the very uncomfortable legal position of being asked by DWQ to accept an NPDES permit limit that the municipality cannot verify they are capable of achieving. Rocky Mount's stream dilution factor is larger than some communities in North Carolina and we still expect difficulties with this new proposed standard.

331 South Franklin Street • Post Office Box 1180 • Rocky Mount, North Carolina 27802-1180
Telephone (252) 972-1400 • Fax (252) 972-1424 • Website: www.ci.rocky-mount.nc.us

Regardless of whether a NPDES permit limit is imposed on our POTW and regardless of whether that value can be measured in a laboratory, the DWQ Pretreatment Unit requires the use of the water quality standard when calculating a Maximum Allowable Headworks Loading [MAHL] for cadmium. A "Maximum Allowable Headworks Loading" calculation results in the amount of cadmium that can be permitted to enter the treatment plant and still mathematically and theoretically have the plant effluent meet the water quality standard.

The City of Rocky Mount's Maximum Allowable Headworks Loading for cadmium using the current 2.0 ug/l North Carolina water quality standard is 1.29 pounds/day. Using the proposed water quality standard of 0.16 ug/l results in a Maximum Allowable Headworks Loading of 0.2 lb/day pounds. The calculated cadmium loading from domestic sources alone is 0.186 pounds/day. We have industrial allocations of 0.44 lb/day. Therefore, the new standard will result in an immediate overallocation scenario for cadmium at our plant. Remedying this over-allocation will require slashing of allowable industrial loadings by 97%. This will cause all SIU's (employing thousands) to evaluate whether they should shutter operations or spend large capital to comply with new limits.

Current DWQ Pretreatment Unit policy prohibits overallocation of any pollutant and requires immediate resolution of the overallocation situation. In the instance where domestic sources alone cause an overallocation, there is absolutely no cadmium capacity for industrial users. No industrial user would be allowed to discharge a detectable level of cadmium at any time. *Of equal importance, no new industrial dischargers with detectable levels of cadmium could locate in any city with cadmium overallocation.* The North Carolina Department of Commerce will not be able to recruit any new industry to North Carolina if the industrial wastewater contains detectable amounts of cadmium, because this new standard will be state-wide and many wastewater treatment plants will have no cadmium allocation to give.

Since domestic wastewater often contains detectable levels of cadmium, even municipalities that receive predominantly domestic wastewater may be impacted negatively if the proposed standard is adopted. Overallocation would still have to be addressed and potentially a moratorium could be issued by DWQ for domestic connections as well.

A review of historical industrial user data for cadmium in North Carolina cities has shown trace/detectable levels of cadmium in the wastewater discharges from the following categories of industries:

331 South Franklin Street • Post Office Box 1180 • Rocky Mount, North Carolina 27802-1180
Telephone (252) 972-1400 • Fax (252) 972-1424 • Website: www.ci.rocky-mount.nc.us

Ms. Connie Brower
North Carolina Department of Environment and Natural Resources
Page 3
September 1, 2006

Soft Drink Manufacturer	Meat Packers	Potato Chip Manufacturer
Personal Care/Personal Hygiene Products	Industrial/Commercial Laundries	Bread/Bakery Product Manufacturing
Pharmaceutical Manufacturing Facilities	Circuit Board Manufacturing Facility	Electrical and Electronic Components Manufacturing Facility
Centralized Waste Treatment Facilities	Transportation Equipment Cleaning Facilities	Metal Finishing Facilities
Electroplating Facilities	Textile Facilities	Photofinishing Facilities
Metal Products and Machinery Facilities	Organic Chemical Manufacturing Facilities	Inorganic Chemical Manufacturing Facilities
Chemical Repackaging Facilities	Tire Manufacturing Facilities	Printing and Publishing Facilities

The City of Rocky Mount has recorded detectable levels of cadmium in the following industrial categories: Bakeries, Metal Finishers, Pharmaceuticals, Textiles, and Industrial Laundry.

Many of these facilities will not be able to control the trace levels of cadmium and if we must enforce the new water quality standard and resulting cadmium MAHLs and local limits, theses facilities will have no choice but to shut down, particularly all of the metal finishing facilities, even those that do not plate cadmium.

Our POTW occasionally has detectable levels of cadmium at the influent of the treatment plant. Our NPDES permit currently requires at least quarterly Whole Effluent Toxicity testing conducted using POTW effluent concentrations equal to 7Q10 conditions in the receiving stream (7 day lowest flow in a 10 year period). The results of our tests routinely show "No Observable Acute or Chronic Effect" at these low flow conditions.

The North Carolina Pretreatment Consortium will present detailed information concerning issues with the EPA study upon which the proposed standard is based. The decision on the proposed change in the cadmium water quality standard should be delayed until the issues raised can be addressed and the impacts on North Carolina pretreatment programs, NPDES permits, and economic development can be assessed.

We appreciate the opportunity to comment on this very important topic.

Sincerely,

Angela Boswell
Pretreatment Coordinator
City of Rocky Mount

331 South Franklin Street • Post Office Box 1180 • Rocky Mount, North Carolina 27802-1180
Telephone (252) 972-1400 • Fax (252) 972-1424 • Website: *www.ci.rocky-mount.nc.us*

DATE: September 1, 2006

Ms. Connie Brower
North Carolina Department of Environment and Natural Resources
DWQ Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: Proposed Change for Cadmium Freshwater Water Quality Standard
2006 Triennial Review

Dear Ms. Brower,

I am the Environmental Services Manager for Salisbury-Rowan Utilities and I am writing to oppose the proposed change in the freshwater water quality standard for cadmium. The proposed change from 2 ppb to 0.16 ppb will impact Salisbury-Rowan Utilities dramatically.

Salisbury-Rowan Utilities Pretreatment Program information is as follows:

- Population Served: 43,500
- Number of POTWs: 1
- Total Permitted Capacity: 12.5 MGD
- Number of Significant Industrial Users: 09

There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium down to 0.16 ug/l, nor am I aware of any commercial or municipal laboratory in North Carolina that can measure cadmium to the concentration of the proposed standard. Even the State DWQ laboratory does not have the capability to measure to that level. The current acceptable detection limit for most EPA approved methods for cadmium is 2.0 ug/l.

Wastewater treatment plants located on very low flow streams in North Carolina typically receive the state water quality standard as an NPDES permit limit since there is no dilution factor. If the water quality standard is changed to 0.16 ppb, that limit will be placed in the NPDES permits of plants on low flow streams. The municipality is in the very uncomfortable legal position of being asked by DWQ to accept an NPDES permit limit that the municipality cannot verify they are capable of achieving.

Current DWQ Pretreatment Unit policy prohibits overallocation of any pollutant and requires immediate resolution of the overallocation situation. In the instance where domestic sources alone cause an overallocation, there is absolutely no cadmium capacity for industrial users. No industrial user would be allowed to discharge a detectable level of cadmium at any time. *Of* *equal importance, no new industrial dischargers with detectable levels of cadmium could locate in any city with cadmium overallocation.*

Since domestic wastewater often contains detectable levels of cadmium, even municipalities that receive predominantly domestic wastewater may be impacted negatively if the proposed standard is adopted. Overallocation would still have to be addressed and potentially a moratorium could be issued by DWQ for domestic connections as well.

Our POTW occasionally has detectable levels of cadmium at the influent of the treatment plant. Our NPDES permit currently requires at least quarterly Whole Effluent Toxicity testing conducted using POTW effluent concentrations equal to 7Q10 conditions in the receiving stream (7 day lowest flow in a 10 year period). The results of our tests routinely show "No Observable Acute or Chronic Effect" at these low flow conditions.

The North Carolina Pretreatment Consortium will present detailed information concerning issues with the EPA study upon which the proposed standard is based. The decision on the proposed change in the cadmium water quality standard should be delayed until the issues raised can be addressed and the impacts on North Carolina pretreatment programs, NPDES permits, and economic development can be assessed.

We appreciate the opportunity to comment on this very important topic.

Sincerely,

Carol Hamilton

Carol Hamilton
Environmental Services Manager
Salisbury-Rowan Utilities

1915 Grubb Ferry Road
Salisbury, NC 28144

Salisbury-Rowan Utilities
Environmental Services Division

Telephone (704) 638-5375
Fax (704) 638-8541

City of Thomasville
Hamby Creek WWTP

August 31, 2006

Ms. Connie Brower [connie.brower@ncmail.net]
North Carolina Department of Environment and Natural Resources
DWQ Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: Proposed Change for Cadmium Freshwater Water Quality Standard
2006 Triennial Review

Dear Ms. Brower,

I am the Lab Supervisor with Pretreatment responsibilities for the City of Thomasville and I am writing to oppose the proposed change in the freshwater water quality standard for cadmium. The proposed change from 2 ppb to 0.16 ppb will impact our City dramatically.

The City of Thomasville Pretreatment Program information is as follows:

- Population Served: 25,090
- Number of POTWs: one
- Total Permitted Capacity: 4.0 MGD
- Number of Significant Industrial Users: eight

There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium down to 0.16 ug/l, nor am I aware of any commercial or municipal laboratory in North Carolina that can measure cadmium to the concentration of the proposed standard. Even the State DWQ laboratory does not have the capability to measure to that level. The current acceptable detection limit for most EPA approved methods for cadmium is 2.0 ug/l.

Wastewater treatment plants located on very low flow streams in North Carolina typically receive the state water quality standard as an NPDES permit limit since there is no dilution factor. If the water quality standard is changed to 0.16 ppb, that limit will be placed in the NPDES permits of plants on low flow streams. The municipality is in the very uncomfortable legal position of being asked by DWQ to accept an NPDES permit limit that the municipality cannot verify they are capable of achieving.

Regardless of whether a NPDES permit limit is imposed on our POTW and regardless of whether that value can be measured in a laboratory, the DWQ Pretreatment Unit requires the use of the water quality standard when calculating a Maximum Allowable Headworks Loading [MAHL] for cadmium. A "Maximum Allowable Headworks Loading" calculation results in the amount of cadmium that can be permitted to enter the treatment plant and still mathematically and theoretically have the plant effluent meet the water quality standard.

PO Box 368
Thomasville, NC 27361

Phone: 336-475-4246
Fax: 336-476-0130

The City of Thomasville Maximum Allowable Headworks Loading for cadmium using the current 2.0 ug/l North Carolina water quality standard is 0.1474 pounds per day. Using the proposed water quality standard of 0.16 ug/l, results in a Maximum Allowable Headworks Loading of 0.0112 pounds per day. The calculated cadmium loading from domestic sources alone is 0.0133 pounds per day. Therefore, the new standard will result in an immediate overallocation scenario for cadmium at our plant, even without any additional industrial loading.

Current DWQ Pretreatment Unit policy prohibits overallocation of any pollutant and requires immediate resolution of the overallocation situation. In this instance where domestic sources alone cause an overallocation, there is absolutely no cadmium capacity for industrial users. No industrial user would be allowed to discharge a detectable level of cadmium at any time. *Of equal importance, no new industrial dischargers with detectable levels of cadmium could locate in any city with cadmium overallocation.* The North Carolina Department of Commerce will not be able to recruit any new industry to North Carolina if the industrial wastewater contains detectable amounts of cadmium, because this new standard will be state-wide and many wastewater treatment plants will have no cadmium allocation to give.

Since domestic wastewater often contains detectable levels of cadmium, even municipalities that receive predominantly domestic wastewater may be impacted negatively if the proposed standard is adopted. Overallocation would still have to be addressed and potentially a moratorium could be issued by DWQ for domestic connections as well. For Thomasville, this would mean no additional sewer connections.

A review of historical industrial user data for cadmium in North Carolina cities has shown trace/detectable levels of cadmium in the wastewater discharges from the following categories of industries:

Soft Drink Manufacturer	Meat Packers	Potato Chip Manufacturer
Personal Care/Personal Hygiene Products	Industrial/Commercial Laundries	Bread/Bakery Product Manufacturing
Pharmaceutical Manufacturing Facilities	Circuit Board Manufacturing Facility	Electrical and Electronic Components Manufacturing Facility
Centralized Waste Treatment Facilities	Transportation Equipment Cleaning Facilities	Metal Finishing Facilities
Electroplating Facilities	Textile Facilities	Photofinishing Facilities
Metal Products and Machinery Facilities	Organic Chemical Manufacturing Facilities	Inorganic Chemical Manufacturing Facilities
Chemical Repackaging Facilities	Tire Manufacturing Facilities	Printing and Publishing Facilities

The City of Thomasville has recorded detectable levels of cadmium in the following industrial categories: Textiles

Many of these facilities will not be able to control the trace levels of cadmium and if we must enforce the new water quality standard and resulting cadmium MAHLs and local limits, theses facilities will have no choice but to shut down, particularly all of the metal finishing facilities, even those that do not plate cadmium.

Our POTW rarely has detectable levels of cadmium at the influent of the treatment plant. Our NPDES permit currently requires at least quarterly Whole Effluent Toxicity testing conducted using POTW effluent concentrations equal to 7Q10 conditions in the receiving stream (7 day lowest flow in a 10 year period). The results of our tests routinely show "No Observable Acute or Chronic Effect" at these low flow conditions.

The North Carolina Pretreatment Consortium will present detailed information concerning issues with the EPA study upon which the proposed standard is based. The decision on the proposed change in the cadmium water quality standard should be delayed until the issues raised can be addressed and the impacts on North Carolina pretreatment programs, NPDES permits, and economic development can be assessed.

We appreciate the opportunity to comment on this very important topic.

Sincerely,

Leigh A. "Misty" Conder
Lab Supervisor, Hamby Creek WWTP
City of Thomasville

CITY OF THOMASVILLE

P.O. Box 368
Thomasville, North Carolina 27361-0368
(336) 475-4222

INCORPORATED 1857

Office of City Manager

August 31, 2006

Ms. Connie Brower [connie.brower@ncmail.net]
North Carolina Department of Environment and Natural Resources
DWQ Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: Proposed Change for Cadmium Freshwater Water Quality Standard
2006 Triennial Review

Dear Ms. Brower,

I am the Interim City Manager and Utilities Director for the City of Thomasville and I am writing to oppose the proposed change in the freshwater water quality standard for cadmium. The proposed change from 2 ppb to 0.16 ppb will impact our City dramatically.

The City of Thomasville Pretreatment Program information is as follows:

- Population Served: 25,090
- Number of POTWs: one
- Total Permitted Capacity: 4.0 MGD
- Number of Significant Industrial Users: eight

There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium down to 0.16 ug/l, nor am I aware of any commercial or municipal laboratory in North Carolina that can measure cadmium to the concentration of the proposed standard. Even the State DWQ laboratory does not have the capability to measure to that level. The current acceptable detection limit for most EPA approved methods for cadmium is 2.0 ug/l.

Wastewater treatment plants located on very low flow streams in North Carolina typically receive the state water quality standard as an NPDES permit limit since there is no dilution factor. If the water quality standard is changed to 0.16 ppb, that limit will be placed in the NPDES permits of plants on low flow streams. The municipality is in the very uncomfortable legal position of being asked by DWQ to accept an NPDES permit limit that the municipality cannot verify they are capable of achieving.

Regardless of whether a NPDES permit limit is imposed on our POTW and regardless of whether that value can be measured in a laboratory, the DWQ Pretreatment Unit requires the use of the water quality standard when calculating a Maximum Allowable Headworks

Loading [MAHL] for cadmium. A "Maximum Allowable Headworks Loading" calculation results in the amount of cadmium that can be permitted to enter the treatment plant and still mathematically and theoretically have the plant effluent meet the water quality standard.

The City of Thomasville Maximum Allowable Headworks Loading for cadmium using the current 2.0 ug/l North Carolina water quality standard is 0.1474 pounds per day. Using the proposed water quality standard of 0.16 ug/l, results in a Maximum Allowable Headworks Loading of 0.0112 pounds per day. The calculated cadmium loading from domestic sources alone is 0.0133 pounds per day. Therefore, the new standard will result in an immediate overallocation scenario for cadmium at our plant, even without any additional industrial loading.

Current DWQ Pretreatment Unit policy prohibits overallocation of any pollutant and requires immediate resolution of the overallocation situation. In this instance where domestic sources alone cause an overallocation, there is absolutely no cadmium capacity for industrial users. No industrial user would be allowed to discharge a detectable level of cadmium at any time. *Of equal importance, no new industrial dischargers with detectable levels of cadmium could locate in any city with cadmium overallocation.* The North Carolina Department of Commerce will not be able to recruit any new industry to North Carolina if the industrial wastewater contains detectable amounts of cadmium, because this new standard will be state-wide and many wastewater treatment plants will have no cadmium allocation to give.

Since domestic wastewater often contains detectable levels of cadmium, even municipalities that receive predominantly domestic wastewater may be impacted negatively if the proposed standard is adopted. Overallocation would still have to be addressed and potentially a moratorium could be issued by DWQ for domestic connections as well. For Thomasville, this would mean no additional sewer connections.

A review of historical industrial user data for cadmium in North Carolina cities has shown trace/detectable levels of cadmium in the wastewater discharges from the following categories of industries:

Soft Drink Manufacturer	Meat Packers	Potato Chip Manufacturer
Personal Care/Personal Hygiene Products	Industrial/Commercial Laundries	Bread/Bakery Product Manufacturing
Pharmaceutical Manufacturing Facilities	Circuit Board Manufacturing Facility	Electrical and Electronic Components Manufacturing Facility
Centralized Waste Treatment Facilities	Transportation Equipment Cleaning Facilities	Metal Finishing Facilities
Electroplating Facilities	Textile Facilities	Photofinishing Facilities
Metal Products and Machinery Facilities	Organic Chemical Manufacturing Facilities	Inorganic Chemical Manufacturing Facilities
Chemical Repackaging Facilities	Tire Manufacturing Facilities	Printing and Publishing Facilities

The City of Thomasville has recorded detectable levels of cadmium in the following industrial categories: Textiles

Many of these facilities will not be able to control the trace levels of cadmium and if we must enforce the new water quality standard and resulting cadmium MAHLs and local limits, theses facilities will have no choice but to shut down, particularly all of the metal finishing facilities, even those that do not plate cadmium.

Our POTW rarely has detectable levels of cadmium at the influent of the treatment plant. Our NPDES permit currently requires at least quarterly Whole Effluent Toxicity testing conducted using POTW effluent concentrations equal to 7Q10 conditions in the receiving stream (7 day lowest flow in a 10 year period). The results of our tests routinely show "No Observable Acute or Chronic Effect" at these low flow conditions.

The North Carolina Pretreatment Consortium will present detailed information concerning issues with the EPA study upon which the proposed standard is based. The decision on the proposed change in the cadmium water quality standard should be delayed until the issues raised can be addressed and the impacts on North Carolina pretreatment programs, NPDES permits, and economic development can be assessed.

We appreciate the opportunity to comment on this very important topic.

Sincerely,

Kelly Craver

Kelly Craver
Interim City Manager
Utilities Director
City of Thomasville

City of Thomasville
Hamby Creek WWTP

August 31, 2006

Ms. Connie Brower [connie.brower@ncmail.net]
North Carolina Department of Environment and Natural Resources
DWQ Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: Proposed Change for Cadmium Freshwater Water Quality Standard
2006 Triennial Review

Dear Ms. Brower,

I am the Plant Superintendent for the City of Thomasville and I am writing to oppose the proposed change in the freshwater water quality standard for cadmium. The proposed change from 2 ppb to 0.16 ppb will impact our City dramatically.

The City of Thomasville Pretreatment Program information is as follows:

- Population Served: 25,090
- Number of POTWs: one
- Total Permitted Capacity: 4.0 MGD
- Number of Significant Industrial Users: eight

There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium down to 0.16 ug/l, nor am I aware of any commercial or municipal laboratory in North Carolina that can measure cadmium to the concentration of the proposed standard. Even the State DWQ laboratory does not have the capability to measure to that level. The current acceptable detection limit for most EPA approved methods for cadmium is 2.0 ug/l.

Wastewater treatment plants located on very low flow streams in North Carolina typically receive the state water quality standard as an NPDES permit limit since there is no dilution factor. If the water quality standard is changed to 0.16 ppb, that limit will be placed in the NPDES permits of plants on low flow streams. The municipality is in the very uncomfortable legal position of being asked by DWQ to accept an NPDES permit limit that the municipality cannot verify they are capable of achieving.

Regardless of whether a NPDES permit limit is imposed on our POTW and regardless of whether that value can be measured in a laboratory, the DWQ Pretreatment Unit requires the use of the water quality standard when calculating a Maximum Allowable Headworks Loading [MAHL] for cadmium. A "Maximum Allowable Headworks Loading" calculation results in the amount of cadmium that can be permitted to enter the treatment plant and still mathematically and theoretically have the plant effluent meet the water quality standard.

PO Box 368
Thomasville, NC 27361

Phone: 336-475-4246
Fax: 336-476-0130

The City of Thomasville Maximum Allowable Headworks Loading for cadmium using the current 2.0 ug/l North Carolina water quality standard is 0.1474 pounds per day. Using the proposed water quality standard of 0.16 ug/l, results in a Maximum Allowable Headworks Loading of 0.0112 pounds per day. The calculated cadmium loading from domestic sources alone is 0.0133 pounds per day. Therefore, the new standard will result in an immediate overallocation scenario for cadmium at our plant, even without any additional industrial loading.

Current DWQ Pretreatment Unit policy prohibits overallocation of any pollutant and requires immediate resolution of the overallocation situation. In this instance where domestic sources alone cause an overallocation, there is absolutely no cadmium capacity for industrial users. No industrial user would be allowed to discharge a detectable level of cadmium at any time. *Of equal importance, no new industrial dischargers with detectable levels of cadmium could locate in any city with cadmium overallocation.* The North Carolina Department of Commerce will not be able to recruit any new industry to North Carolina if the industrial wastewater contains detectable amounts of cadmium, because this new standard will be state-wide and many wastewater treatment plants will have no cadmium allocation to give.

Since domestic wastewater often contains detectable levels of cadmium, even municipalities that receive predominantly domestic wastewater may be impacted negatively if the proposed standard is adopted. Overallocation would still have to be addressed and potentially a moratorium could be issued by DWQ for domestic connections as well. For Thomasville, this would mean no additional sewer connections.

A review of historical industrial user data for cadmium in North Carolina cities has shown trace/detectable levels of cadmium in the wastewater discharges from the following categories of industries:

Soft Drink Manufacturer	Meat Packers	Potato Chip Manufacturer
Personal Care/Personal Hygiene Products	Industrial/Commercial Laundries	Bread/Bakery Product Manufacturing
Pharmaceutical Manufacturing Facilities	Circuit Board Manufacturing Facility	Electrical and Electronic Components Manufacturing Facility
Centralized Waste Treatment Facilities	Transportation Equipment Cleaning Facilities	Metal Finishing Facilities
Electroplating Facilities	Textile Facilities	Photofinishing Facilities
Metal Products and Machinery Facilities	Organic Chemical Manufacturing Facilities	Inorganic Chemical Manufacturing Facilities
Chemical Repackaging Facilities	Tire Manufacturing Facilities	Printing and Publishing Facilities

The City of Thomasville has recorded detectable levels of cadmium in the following industrial categories: Textiles

Many of these facilities will not be able to control the trace levels of cadmium and if we must enforce the new water quality standard and resulting cadmium MAHLs and local limits, theses facilities will have no choice but to shut down, particularly all of the metal finishing facilities, even those that do not plate cadmium.

Our POTW rarely has detectable levels of cadmium at the influent of the treatment plant. Our NPDES permit currently requires at least quarterly Whole Effluent Toxicity testing conducted using POTW effluent concentrations equal to 7Q10 conditions in the receiving stream (7 day lowest flow in a 10 year period). The results of our tests routinely show "No Observable Acute or Chronic Effect" at these low flow conditions.

The North Carolina Pretreatment Consortium will present detailed information concerning issues with the EPA study upon which the proposed standard is based. The decision on the proposed change in the cadmium water quality standard should be delayed until the issues raised can be addressed and the impacts on North Carolina pretreatment programs, NPDES permits, and economic development can be assessed.

We appreciate the opportunity to comment on this very important topic.

Sincerely,

Morgan D. Huffman
Plant Superintendent, Hamby Creek WWTP
City of Thomasville

Winston-Salem • Forsyth County
City/County Utilities
Water • Sewer • Solid Waste Disposal

A-217

Manson Meads Complex • 2799 Griffith Road • Winston-Salem, NC 27103 • Tel 336.765.0130 • Fax 336.659.4320

CORRECTED COPY

August 31, 2006

Ms. Connie Brower
North Carolina Department of Environment and Natural Resources
DWQ Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: Proposed Change for Cadmium Freshwater Water Quality Standard
2006 Triennial Review

Dear Ms. Brower:

I am the Pretreatment Coordinator for the City of City of Winston-Salem and I am writing to oppose the proposed change in the freshwater water quality standard for cadmium. The proposed change from 2 ppb to 0.16 ppb will impact Winston-Salem dramatically.

The City of Winston-Salem Pretreatment Program information is as follows:

- Population Served: 225,000
- Number of POTWs: 2
- Total Permitted Capacity: 51 MGD
- Number of Significant Industrial Users: 38

There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium down to 0.16 ug/l, nor am I aware of any commercial or municipal laboratory in North Carolina that can measure cadmium to the concentration of the proposed standard. Even the State DWQ laboratory does not have the capability to measure to that level. The current acceptable detection limit for most EPA approved methods for cadmium is 2.0 ug/l.

Wastewater treatment plants located on very low flow streams in North Carolina typically receive the state water quality standard as an NPDES permit limit since there is no dilution factor. If the water quality standard is changed to 0.16 ppb, that limit will be placed in the NPDES permits of plants on low flow streams. The municipality is in the very uncomfortable legal position of being asked by DWQ to accept an NPDES permit limit that the municipality cannot verify they are capable of achieving.

Regardless of whether a NPDES permit limit is imposed on our POTW and regardless of whether that value can be measured in a laboratory, the DWQ Pretreatment Unit requires the use of the water quality standard when calculating a Maximum Allowable Headworks Loading

[MAHL] for cadmium. A "Maximum Allowable Headworks Loading" calculation results in the amount of cadmium that can be permitted to enter the treatment plant and still mathematically and theoretically have the plant effluent meet the water quality standard.

The City of Winston-Salem's Archie Elledge POTWs Maximum Allowable Headworks Loading for cadmium using the current 2.0 ug/l North Carolina water quality standard is 1.5012 pounds. Using the proposed water quality standard of 0.16 ug/l results in a Maximum Allowable Headworks Loading of 0.120 pounds. The calculated cadmium loading from domestic sources alone is 0.252 pounds. Therefore, the new standard will result in an immediate overallocation scenario for cadmium at our plant.

Current DWQ Pretreatment Unit policy prohibits overallocation of any pollutant and requires immediate resolution of the overallocation situation. In the instance where domestic sources alone cause an overallocation, there is absolutely no cadmium capacity for industrial users. No industrial user would be allowed to discharge a detectable level of cadmium at any time. *Of equal importance, no new industrial dischargers with detectable levels of cadmium could locate in any city with cadmium overallocation.* The North Carolina Department of Commerce will not be able to recruit any new industry to North Carolina if the industrial wastewater contains detectable amounts of cadmium, because this new standard will be state-wide and many wastewater treatment plants will have no cadmium allocation to give.

Since domestic wastewater often contains detectable levels of cadmium, even municipalities that receive predominantly domestic wastewater may be impacted negatively if the proposed standard is adopted. Overallocation would still have to be addressed and potentially a moratorium could be issued by DWQ for domestic connections as well.

A review of historical industrial user data for cadmium in North Carolina cities has shown trace/detectable levels of cadmium in the wastewater discharges from the following categories of industries:

Soft Drink Manufacturer	Meat Packers	Potato Chip Manufacturer
Personal Care/Personal Hygiene Products	Industrial/Commercial Laundries	Bread/Bakery Product Manufacturing
Pharmaceutical Manufacturing Facilities	Circuit Board Manufacturing Facility	Electrical and Electronic Components Manufacturing Facility
Centralized Waste Treatment Facilities	Transportation Equipment Cleaning Facilities	Metal Finishing Facilities
Electroplating Facilities	Textile Facilities	Photofinishing Facilities
Metal Products and Machinery Facilities	Organic Chemical Manufacturing Facilities	Inorganic Chemical Manufacturing Facilities
Chemical Repackaging Facilities	Tire Manufacturing Facilities	Printing and Publishing Facilities

The City of Winston-Salem has recorded detectable levels of cadmium in the following industrial categories: Metal Finishing, Machine Shop, Soft Drink Manufacturing, Industrial Laundry, Tobacco Processing, Corrugated Box Manufacturing, Transportation Facilities and Centralized Waste Treatment Facilities.

Many of these facilities will not be able to control the trace levels of cadmium and if we must enforce the new water quality standard and resulting cadmium MAHLs and local limits, theses facilities will have no choice but to shut down, particularly all of the metal finishing facilities, even those that do not plate cadmium.

Our POTW occasionally has detectable levels of cadmium at the influent of the treatment plant. Our NPDES permit currently requires at least quarterly Whole Effluent Toxicity testing conducted using POTW effluent concentrations equal to 7Q10 conditions in the receiving stream (7 day lowest flow in a 10 year period). The results of our tests routinely show "No Observable Acute or Chronic Effect" at these low flow conditions.

The North Carolina Pretreatment Consortium will present detailed information concerning issues with the EPA study upon which the proposed standard is based. The decision on the proposed change in the cadmium water quality standard should be delayed until the issues raised can be addressed and the impacts on North Carolina pretreatment programs, NPDES permits, and economic development can be assessed.

We appreciate the opportunity to comment on this very important topic.

Sincerely,

Sherry Bagwell

Sherry Bagwell
Utility Plant Supervisor / IWC
City of Winston-Salem

A-220

Metropolitan Sewerage District

OF BUNCOMBE COUNTY, NORTH CAROLINA

August 31, 2006

Ms. Connie Brower
North Carolina Department of Environment and Natural Resources
DWQ Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: Proposed Change for Cadmium Freshwater Water Quality Standard
2006 Triennial Review

Dear Ms. Brower,

I am the Pretreatment Coordinator for the Metropolitan Sewerage District of Buncombe County, NC (MSD) and I am writing to oppose the proposed change in the freshwater water quality standard for cadmium. The proposed change from 2 ppb to 0.16 ppb will impact MSD dramatically.

The MSD Pretreatment Program information is as follows:

- Population Served: 135,000
- Number of POTWs: One
- Total Permitted Capacity: 40 MGD
- Number of Significant Industrial Users: 22

There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium down to 0.16 ug/l, nor am I aware of any commercial or municipal laboratory in North Carolina that can measure cadmium to the concentration of the proposed standard. Even the State DWQ laboratory does not have the capability to measure to that level. The current acceptable detection limit for most EPA approved methods for cadmium is 2.0 ug/l.

Wastewater treatment plants located on very low flow streams in North Carolina typically receive the state water quality standard as an NPDES permit limit since there is no dilution factor. If the water quality standard is changed to 0.16 ppb, that limit will be placed in the NPDES permits of plants on low flow streams. The municipality is in the very uncomfortable legal position of being asked by DWQ to accept an NPDES permit limit that the municipality cannot verify they are capable of achieving.

Regardless of whether a NPDES permit limit is imposed on our POTW and regardless of whether that value can be measured in a laboratory, the DWQ Pretreatment Unit requires the use of the water quality standard when calculating a Maximum Allowable Headworks

~Protecting Our Natural Resources~

2028 RIVERSIDE DRIVE ASHEVILLE, NORTH CAROLINA 28804 TELEPHONE: (828)254-9646 FAX: (828)232-5537 WEBSITE: www.msdbc.org

Loading [MAHL] for cadmium. A "Maximum Allowable Headworks Loading" calculation results in the amount of cadmium that can be permitted to enter the treatment plant and still mathematically and theoretically have the plant effluent meet the water quality standard.

The MSD's Maximum Allowable Headworks Loading for cadmium using the current 2.0 ug/l North Carolina water quality standard is 16.869 pounds. The proposed water quality standard of 0.16 ug/l results in a Maximum Allowable Headworks Loading of 1.349 pounds. This is a lost of 15,520 pound of allocation, future growth and jobs for the Asheville area. The area, as well as the State, has already seen the lost of major industries over the last few years.

Current DWQ Pretreatment Unit policy prohibits overallocation of any pollutant and requires immediate resolution of the overallocation situation. In the instance where domestic sources alone cause an overallocation, there is absolutely no cadmium capacity for industrial users. No industrial user would be allowed to discharge a detectable level of cadmium at any time. *Of equal importance, no new industrial dischargers with detectable levels of cadmium could locate in any city with cadmium overallocation.* The North Carolina Department of Commerce will not be able to recruit any new industry to North Carolina if the industrial wastewater contains detectable amounts of cadmium, because this new standard will be state-wide and many wastewater treatment plants will have no cadmium allocation to give.

Since domestic wastewater often contains detectable levels of cadmium, even municipalities that receive predominantly domestic wastewater may be impacted negatively if the proposed standard is adopted. Overallocation would still have to be addressed and potentially a moratorium could be issued by DWQ for domestic connections as well.

A review of historical industrial user data for cadmium in North Carolina cities has shown trace/detectable levels of cadmium in the wastewater discharges from the following categories of industries:

Soft Drink Manufacturer	Meat Packers	Potato Chip Manufacturer
Personal Care/Personal Hygiene Products	Industrial/Commercial Laundries	Bread/Bakery Product Manufacturing
Pharmaceutical Manufacturing Facilities	Circuit Board Manufacturing Facility	Electrical and Electronic Components Manufacturing Facility
Centralized Waste Treatment Facilities	Transportation Equipment Cleaning Facilities	Metal Finishing Facilities
Electroplating Facilities	Textile Facilities	Photofinishing Facilities
Metal Products and Machinery Facilities	Organic Chemical Manufacturing Facilities	Inorganic Chemical Manufacturing Facilities
Chemical Repackaging Facilities	Tire Manufacturing Facilities	Printing and Publishing Facilities

The MSD has recorded detectable levels of cadmium in the following industrial categories: electroplating, metal finishing and printed circuit board manufacturing.

Many of these facilities will not be able to control the trace levels of cadmium and if we must enforce the new water quality standard and resulting cadmium MAHLs and local limits, theses facilities will have no choice but to shut down, particularly all of the metal finishing facilities, even those that do not plate cadmium.

Our POTW rarely has detectable levels of cadmium at the influent of the treatment plant. Our NPDES permit currently requires at least quarterly Whole Effluent Toxicity testing conducted using POTW effluent concentrations equal to 7Q10 conditions in the receiving stream (7 day lowest flow in a 10 year period). The results of our tests routinely show "No Observable Acute or Chronic Effect" at these low flow conditions.

The North Carolina Pretreatment Consortium will present detailed information concerning issues with the EPA study upon which the proposed standard is based. The decision on the proposed change in the cadmium water quality standard should be delayed until the issues raised can be addressed and the impacts on North Carolina pretreatment programs, NPDES permits, and economic development can be assessed.

We appreciate the opportunity to comment on this very important topic.

Sincerely,

Monty Payne

Monty Payne
Industrial Waste Coordinator
Metropolitan Sewerage District of Buncombe County, NC

A-223

Department of Public Works
Wastewater Treatment Plant
1094 Addor Road
Aberdeen, NC 28315

Telephone: (910) 281-3146
Facsimile: (910) 281-2047

County of Moore

August 30, 2006

Ms. Connie Brower [connie.brower@ncmail.net]
North Carolina Department of Environment and Natural Resources
DWQ Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: Proposed Change for Cadmium Freshwater Water Quality Standard
2006 Triennial Review

Dear Ms. Brower,

I am the Pretreatment Coordinator for the County of Moore and I am writing to oppose the proposed change in the freshwater water quality standard for cadmium. The proposed change from 2 ppb to 0.16 ppb will impact our County dramatically.

The County of Moore Pretreatment Program information is as follows:

- Population Served: ~ 33,000
- Number of POTWs: 1
- Total Permitted Capacity: 6.7 MGD
- Number of Significant Industrial Users: 2

There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium down to 0.16 ug/l, nor am I aware of any commercial or municipal laboratory in North Carolina that can measure cadmium to the concentration of the proposed standard. Even the State DWQ laboratory does not have the capability to measure to that level. The current acceptable detection limit for most EPA approved methods for cadmium is 2.0 ug/l.

Wastewater treatment plants located on very low flow streams in North Carolina typically receive the state water quality standard as an NPDES permit limit since there is no dilution factor. If the water quality standard is changed to 0.16 ppb, that limit will be placed in the NPDES permits of plants on low flow streams. The municipality is in the very uncomfortable legal position of being asked by DWQ to accept an NPDES permit limit that the municipality cannot verify they are capable of achieving.

Regardless of whether a NPDES permit limit is imposed on our POTW and regardless of whether that value can be measured in a laboratory, the DWQ Pretreatment Unit requires the use of the water quality standard when calculating a Maximum Allowable Headworks

A-224

Department of Public Works
Wastewater Treatment Plant
1094 Addor Road
Aberdeen, NC 28315

Telephone: (910) 281-3146
Facsimile: (910) 281-2047

County of Moore

Loading [MAHL] for cadmium. A "Maximum Allowable Headworks Loading" calculation results in the amount of cadmium that can be permitted to enter the treatment plant and still mathematically and theoretically have the plant effluent meet the water quality standard.

The County of Moore Maximum Allowable Headworks Loading for cadmium using the current 2.0 ug/l North Carolina water quality standard is 0.7366 pounds using only 75% of our plant flow capacity. Using the proposed water quality standard of 0.16 ug/l results in a Maximum Allowable Headworks Loading of 0.0589 pounds. The calculated cadmium loading from domestic sources alone is 0.0391 pounds.

Current DWQ Pretreatment Unit policy prohibits overallocation of any pollutant and requires immediate resolution of the overallocation situation. In the instance where domestic sources alone cause an overallocation, there is absolutely no cadmium capacity for industrial users. No industrial user would be allowed to discharge a detectable level of cadmium at any time. *Of equal importance, no new industrial dischargers with detectable levels of cadmium could locate in any city with cadmium overallocation.* The North Carolina Department of Commerce will not be able to recruit any new industry to North Carolina if the industrial wastewater contains detectable amounts of cadmium, because this new standard will be state-wide and many wastewater treatment plants will have no cadmium allocation to give.

Since domestic wastewater often contains detectable levels of cadmium, even municipalities that receive predominantly domestic wastewater may be impacted negatively if the proposed standard is adopted. Overallocation would still have to be addressed and potentially a moratorium could be issued by DWQ for domestic connections as well.

A review of historical industrial user data for cadmium in North Carolina cities has shown trace/detectable levels of cadmium in the wastewater discharges from the following categories of industries:

Soft Drink Manufacturer	Meat Packers	Potato Chip Manufacturer
Personal Care/Personal Hygiene Products	Industrial/Commercial Laundries	Bread/Bakery Product Manufacturing
Pharmaceutical Manufacturing Facilities	Circuit Board Manufacturing Facility	Electrical and Electronic Components Manufacturing Facility
Centralized Waste Treatment Facilities	Transportation Equipment Cleaning Facilities	Metal Finishing Facilities

A-225

Department of Public Works
Wastewater Treatment Plant
1094 Addor Road
Aberdeen, NC 28315

Telephone: (910) 281-3146
Facsimile: (910) 281-2047

County of Moore

Electroplating Facilities	Textile Facilities	Photofinishing Facilities
Metal Products and Machinery Facilities	Organic Chemical Manufacturing Facilities	Inorganic Chemical Manufacturing Facilities
Chemical Repackaging Facilities	Tire Manufacturing Facilities	Printing and Publishing Facilities

The County of Moore has recorded detectable levels of cadmium in the following industrial categories: metal finishers and textile plants

Many of these facilities will not be able to control the trace levels of cadmium and if we must enforce the new water quality standard and resulting cadmium MAHLs and local limits, theses facilities will have no choice but to shut down, particularly all of the metal finishing facilities, even those that do not plate cadmium.

Our POTW rarely has detectable levels of cadmium at the influent of the treatment plant. Our NPDES permit currently requires at least quarterly Whole Effluent Toxicity testing conducted using POTW effluent concentrations equal to 7Q10 conditions in the receiving stream (7 day lowest flow in a 10 year period). The results of our tests routinely show "No Observable Acute or Chronic Effect" at these low flow conditions.

The North Carolina Pretreatment Consortium will present detailed information concerning issues with the EPA study upon which the proposed standard is based. The decision on the proposed change in the cadmium water quality standard should be delayed until the issues raised can be addressed and the impacts on North Carolina pretreatment programs, NPDES permits, and economic development can be assessed.

We appreciate the opportunity to comment on this very important topic.

Sincerely,

Stephanie A. Brixey

Stephanie A. Brixey
Lab Supervisor/Pretreatment Coordinator
County of Moore

THE PEAK OF GOOD LIVING

Town of Apex

P. O. BOX 250
APEX, NORTH CAROLINA 27502

8/30/06

Ms. Connie Brower [connie.brower@ncmail.net]
North Carolina Department of Environment and Natural Resources
DWQ Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: Proposed Change for Cadmium Freshwater Water Quality Standard
2006 Triennial Review

Dear Ms. Brower,

I am the Pretreatment Coordinator for the Town of Apex and I am writing to oppose the proposed change in the freshwater water quality standard for cadmium. The proposed change from 2 ppb to 0.16 ppb will impact our Town dramatically.

The Town of Apex Pretreatment Program information is as follows:

- Population Served: 30,931
- Number of POTWs: One
- Total Permitted Capacity: 3.6 MGD
- Number of Significant Industrial Users: Four

There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium down to 0.16 ug/l, nor am I aware of any commercial or municipal laboratory in North Carolina that can measure cadmium to the concentration of the proposed standard. Even the State DWQ laboratory does not have the capability to measure to that level. The current acceptable detection limit for most EPA approved methods for cadmium is 2.0 ug/l.

Wastewater treatment plants located on very low flow streams in North Carolina typically receive the state water quality standard as an NPDES permit limit since there is no dilution factor. If the water quality standard is changed to 0.16 ppb, that limit will be placed in the NPDES permits of plants on low flow streams. The municipality is in the very uncomfortable legal position of being asked by DWQ to accept an NPDES permit limit that the municipality cannot verify they are capable of achieving.

Regardless of whether a NPDES permit limit is imposed on our POTW and regardless of whether that value can be measured in a laboratory, the DWQ Pretreatment Unit requires the use of the water quality standard when calculating a Maximum Allowable Headworks Loading [MAHL] for cadmium. A "Maximum Allowable Headworks Loading" calculation results in the amount of cadmium that can be permitted to enter the treatment plant and still mathematically and theoretically have the plant effluent meet the water quality standard.

period). The results of our tests routinely show "No Observable Acute or Chronic Effect" at these low flow conditions.

The North Carolina Pretreatment Consortium will present detailed information concerning issues with the EPA study upon which the proposed standard is based. The decision on the proposed change in the cadmium water quality standard should be delayed until the issues raised can be addressed and the impacts on North Carolina pretreatment programs, NPDES permits, and economic development can be assessed.

We appreciate the opportunity to comment on this very important topic.

Sincerely,

David Hardin
Pretreatment Coordinator
Town of Apex

WSACC
WATER & SEWER AUTHORITY
OF CABARRUS COUNTY

August 30, 2006

Office: 232 Davidson Hwy.
Concord, NC 28027
A-228
Mail to: P.O. Box 428
Concord, NC 28026-0428

Phone: 704.786.1783
Fax: 704.795.1564

Ms. Connie Brower
North Carolina Department of Environment and Natural Resources
DWQ Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: PROPOSED CHANGE FOR CADMIUM FRESHWATER QUALITY STANDARD 2006 TRIENNIAL REVIEW

Dear Ms. Brower:

The Water & Sewer Authority of Cabarrus County (WSACC) is opposing the proposed change in the freshwater water quality standard for cadmium. The proposed change from 2 ppb to 0.16 ppb will impact our service area, the Cities of Concord and Kannapolis, the Towns of Harrisburg and Mt. Pleasant, and Cabarrus County dramatically.

WSACC's Pretreatment Program information is as follows:

- Population Served: 167,000
- Number of POTWs: 1
- Total Permitted Capacity: 24 MGD
- Number of Significant Industrial Users: 17

There is currently no EPA approved wastewater laboratory analytical method listed in 40 CFR Part 136 that can measure cadmium down to 0.16 ug/l, nor am I aware of any commercial or municipal laboratory in North Carolina that can measure cadmium to the concentration of the proposed standard. Even the State DWQ laboratory does not have the capability to measure to that level. The current acceptable detection limit for most EPA approved methods for cadmium is 2.0 ug/l.

Wastewater treatment plants located on very low flow streams in North Carolina typically receive the state water quality standard as an NPDES permit limit since there is no dilution factor. If the water quality standard is changed to 0.16 ppb, that limit will be placed in the NPDES permits of plants on low flow streams. The municipality is in the very uncomfortable legal position of being asked by DWQ to accept an NPDES permit limit that the municipality cannot verify they are capable of achieving.

Regardless of whether a NPDES permit limit is imposed on our POTW and regardless of whether that value can be measured in a laboratory, the DWQ Pretreatment Unit requires the use of the water quality standard when calculating a Maximum Allowable Headworks Loading [MAHL] for cadmium. A "Maximum Allowable Headworks Loading" calculation results in the amount of cadmium that can be permitted to enter the treatment plant and still mathematically and theoretically have the plant effluent meet the water quality standard.

WSACC's Maximum Allowable Headworks Loading for cadmium using the current 2.0 ug/l North Carolina water quality standard is 1.085 pounds. Using the proposed water quality standard of 0.16 ug/l results in a Maximum Allowable Headworks Loading of 0.0945 pounds. The calculated cadmium loading from domestic sources alone is 0.1677 pounds. **Therefore, the new standard will result in an immediate overallocation scenario for cadmium at our plant.**

Current DWQ Pretreatment Unit policy prohibits overallocation of any pollutant and requires immediate resolution of the overallocation situation. In the instance where domestic sources alone cause an overallocation, there is absolutely no cadmium capacity for industrial users. No industrial user would be allowed to discharge a detectable level of cadmium at any time. *Of equal importance, no new industrial dischargers with detectable levels of cadmium could locate in any city with cadmium overallocation.* The North Carolina Department of Commerce will not be able to recruit any new industry to North Carolina if the industrial wastewater contains detectable amounts of cadmium, because this new standard will be state-wide and many wastewater treatment plants will have no cadmium allocation to give.

Since domestic wastewater often contains detectable levels of cadmium, even municipalities that receive predominantly domestic wastewater may be impacted negatively if the proposed standard is adopted. Overallocation would still have to be addressed and potentially a moratorium could be issued by DWQ for domestic connections as well.

A review of historical industrial user data for cadmium in North Carolina cities has shown trace/detectable levels of cadmium in the wastewater discharges from the following categories of industries:

Soft Drink Manufacturer	Meat Packers	Potato Chip Manufacturer
Personal Care/Personal Hygiene Products	Industrial/Commercial Laundries	Bread/Bakery Product Manufacturing
Pharmaceutical Manufacturing Facilities	Circuit Board Manufacturing Facility	Electrical and Electronic Components Manufacturing Facility
Centralized Waste Treatment Facilities	Transportation Equipment Cleaning Facilities	Metal Finishing Facilities
Electroplating Facilities	Textile Facilities	Photofinishing Facilities
Metal Products and Machinery Facilities	Organic Chemical Manufacturing Facilities	Inorganic Chemical Manufacturing Facilities
Chemical Repackaging Facilities	Tire Manufacturing Facilities	Printing and Publishing Facilities

WSACC has recorded detectable levels of cadmium in the following industrial categories: Textile Facilities, Chemical Repackaging Facilities, Landfill, Metal Products and Machinery, and Medical Waste Facilities.

Many of these facilities will not be able to control the trace levels of cadmium and if we must enforce the new water quality standard and resulting cadmium MAHLs and local limits, theses facilities will have no choice but to shut down, particularly all of the metal finishing facilities, even those that do not plate cadmium.

Our POTW occasionally has detectable levels of cadmium at the <u>influent</u> of the treatment plant. Our NPDES permit currently requires at least quarterly Whole Effluent Toxicity testing conducted using POTW effluent concentrations equal to 7Q10 conditions in the receiving stream (7 day lowest flow in a 10 year period). The results of our tests routinely show "No Observable Acute or Chronic Effect" at these low flow conditions.

The North Carolina Pretreatment Consortium will present detailed information concerning issues with the EPA study upon which the proposed standard is based. The decision on the proposed change in the cadmium water quality standard should be delayed until the issues raised can be addressed and the impacts on North Carolina pretreatment programs, NPDES permits, and economic development can be assessed.

We appreciate the opportunity to comment on this very important topic.

Sincerely,

Timothy H. Mauldin
Wastewater Operations Manager

Beverly K. Metcalf
Industrial Pretreatment Coordinator

THM:BKM:bll

cc: Central Files

THE NEUSE RIVER COMPLIANCE ASSOCIATION
THE LOWER NEUSE BASIN ASSOCIATION
POST OFFICE BOX 1562
APEX, NORTH CAROLINA 27502

August 29, 2006

Ms. Connie Brower
DENR-Division of Water Quality Planning, Planning Section
1617 Mail Service Center
Raleigh, North Carolina 27699-1617

Dear Ms. Brower:

The Lower Neuse Basin Association (LNBA) and the Neuse River Compliance Association (NRCA) are comprised of 22 municipalities, industries and private utilities that are permitted to discharge treated wastewater to the Neuse River. The group has been in existence since the mid 1990's and has worked diligently to remove nitrogen and other pollutants from their discharges to protect and improve the Neuse River and its estuary.

The purpose of this letter is to provide our comments on the Triennial Review and the proposed changes to the water quality standards. Specifically, we would offer comment on the proposed change in the total cadmium standard from 2.0 ppb to 0.16 ppb. The members of the LNBA and the NRCA are concerned about the consequences of a change in this standard in three areas: laboratory detection levels, implementation of NPDES permit limits and implications for the pretreatment programs in North Carolina.

There is currently no EPA approved analytical method available to measure total cadmium to the proposed standard of 0.16 ppb. The current acceptable lower reporting level for EPA methods is 2 parts per billion. No laboratory in North Carolina can measure cadmium to the concentration of the proposed standard. NPDES permittees will not be able to demonstrate compliance with this proposed standard. Due to this limitation in the available technology, the dischargers have no information about the levels of cadmium in their raw or treated wastewater. It may be possible that purely domestic wastewater could exceed this level for total cadmium after treatment and thus account for all available headworks loading.

It is our assumption that language will be developed to be added to the NPDES permits that will state that effluent concentrations that are below the lower reporting level, will be considered compliant. Similar permit implementation has been developed for cyanide and total mercury which would provide a precedent in this situation. However, when the level of technology allows detection of total cadmium to the 0.16 ppb level, every plant in the state may find itself in noncompliance with that standard. With a permit limit that is difficult to refute, plants may find themselves in a legal dilemma, with no hope of determining compliance attainment. It should be noted that current pretreatment technologies may not be available to adequately pretreat affected industrial or commercial wastewater generators to a level at or near the proposed level.

Issues with laboratory detection limits and NPDES compliance attainment are somewhat obvious. The proposed cadmium standard creates significant yet elusive implications for North Carolina's 147 pretreatment programs. The Maximum Allowable Headworks Loading calculations, that are required to be used by pretreatment programs, use specific water quality standards, regardless of whether that value can be accurately measured in the laboratory. This calculation results in the amount of cadmium that can be permitted to enter the treatment plant, while assuring effluent compliance with the water quality standard. The mass balance calculation is used to allocate certain pollutant loadings, in this case, cadmium. Cadmium is allocated to different sources using this calculation, such as industrial, commercial or domestic users. If the proposed stand is adopted, the uncontrollable domestic sources of cadmium may exhaust all of the available loading for cadmium, leaving no allocation for any other sources. In many cases, the plant may already be over-allocated on paper, and deemed by DWQ to be in noncompliance.

Cadmium, in the parts per billion range, exists in industrial/commercial facilities such as metal finishing and electroplating. It also shows up in commercial food preparation operations, laundries, and is further concentrated, often as parts per million, in domestic septage.[1] The technology to provide pretreatment to reduce cadmium to levels acceptable at wastewater plants who must discharge at water quality standards does not currently exist. Treatment plants will find themselves with no cadmium allocation available for new industrial development, and in many cases, may find themselves in noncompliance with their permit and with no method of pretreatment for Cadmium available.

The LNBA and the NRCA support the protection of the surface waters of the state. We understand the basis for this standard but we are very concerned with the implementation issues that adoption of this standard will create. We feel that there must be an implementation policy that will spell out how compliance will be determined as a function of the plants meeting the existing water quality standard of 2 ppb.

We appreciate the opportunity to provide input to the Division on these proposed changes. We remain committed to providing the best wastewater treatment available and in protecting the resources of the State of North Carolina.

Sincerely,

Haywood M. Phthisic, III
Chairman

1. USEPA; Septage Treatment and Disposal, Technology Transfer, MERL Laboratory, Cincinnati, OH. October, 1984, Table 3-5, p. 29

NORTH CAROLINA
AMERICAN WATER WORKS ASSOCIATION

WATER ENVIRONMENT ASSOCIATION

September 1, 2006

Ms. Connie Brower
DENR/Division of Water Quality- Planning Branch
1617 Mail Service Center
Raleigh, NC 27699-1617

Dear Ms. Brower:

On behalf of the North Carolina Section of the American Water Works Association's (AWWA) and Water Environment Association's (WEA) 3,000 members, we are writing to express our concern regarding the proposed changes to the North Carolina Cadmium water quality standards for freshwaters. Our concerns related to this proposed change include laboratory detection levels that are not able to be measured, difficulty in implementing/meeting NPDES permit limits, implications for the pretreatment programs in North Carolina and the economic impacts to the customers served by our member utilities.

We therefore recommend that no change be made to the water quality standard for Cadmium at this time. In addition, it is recommended that a work group be formed to evaluate the issues and assist with the development of recommendations. We would appreciate the opportunity to participate on any work group that may be formed.

On behalf of AWWA and WEA, we appreciate the opportunity to comment on this important issue.

Sincerely,

David Zimmer, P.E., Chair
NC AWWA-WEA Board of Trustees

cc: Mike Osborne, P. E.

August 28, 2006

Ms. Connie Brower
DENR/Division of Water Quality Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

Dear Ms. Brower,

On behalf of Environment North Carolina and North Carolina Conservation Network, thank you for the opportunity to comment on proposed changes in the 2004-2006 Triennial Review of surface water quality standards. We commend recommendations to lower allowable amounts of harmful pollutants such as heptachlor, hexachlorobutadiene, trichloroethylene and cadmium. Although we are supportive of these changes, we cannot support relaxing the standards for chlordane, beryllium, and particularly for tributyltin, a highly toxic chemical.

We would also encourage you to include standards for MTBE and methylmercury during this triennial review. These are two pollutants of concern for many North Carolinians and we believe standards need to be set as soon as possible.

HEPTACHLOR

Heptachlor can cause liver and nervous system damage. Tighter surface water standards are important because humans are often exposed to heptachlor, a possible human carcinogen, by eating fish.

Children are especially sensitive to heptachlor. It has been found that exposure to heptachlor, which is still in use to control fire ants, during gestation and infancy can cause damage to a child's nervous and immune systems. Infants and children can be exposed to heptachlor through breast mild from mothers who have high exposure or from eating fish contaminated with heptachlor.

In light of the devastating affect heptachlor can have, particularly for children, we support adopting a more protective standard for heptachlor.

HEXACHLOROBUTADIENE

Hexachlorobutadiene can build up in fish and shellfish and human are exposed to the pollutant after eating contaminated fish or drinking contaminated water. These two routes of exposure make it important that allowable surface water levels be reduced.

Studies in animals have shown that drinking low levels of hexachlorobutadiene results in kidney and liver damage. Considering the health impacts of hexachlorobutadiene and that the common routes of exposure include surface waters, we support tightening the standards for hexachlorobutadiene.

liver and exposure over even short periods of time can result in depression, tremors and convulsions.

TRIBUTYLTIN

We are opposed to raising the allowable amount of tributyltin (TBT) in our waters. A common use of TBT is as an additive in paints applied to boats, docks, fishnets, and buoys, making it a particular threat to our waters and aquatic species. Although the use of TBT has been restricted for non-aluminum boats shorter than 65 feet, there are many reasons to be concerned about the presence of this pollutant in our waters.

Exposure to TBT can cause skin and eye irritation, making it particular concern for our surface waters, many of which are used for recreation. Prolonged exposure can also lead to kidney and liver damage.

Some of the most devastating effects of TBT are seen in aquatic species. It has been found that TBT biomagnifies through the food chain and has been found in the tissues of aquatic species, including oysters, mussels, crustaceans, mollusks, and fish. Freshwaters species will also bio-accumulate more TBT than marine species, making the impacts on species such as trout more alarming.

Studies have documented the harm TBT causes to Rainbow trout. Higher levels can kill trout eggs while lower levels can impair growth and blood and liver metabolism. Additionally, the presence of low levels of tributyltin oxide over several days can destroy the corneal membranes of the trout's eyes.

Even in low concentrations, TBT causes adverse reproductive and developmental effects in aquatic species. Perhaps most disturbing, TBT is an endocrine disruptor that has been found to cause the superimposition of male anatomical characteristics on females in a variety of species, including 45 species of snails worldwide. This can result in reproductive failure and population declines.

The many ill effects of TBT are a cause of concern. Loosening standards will only put some of our most sensitive and prized species, including trout, at risk. We encourage you to use a margin of safety in setting allowable levels and leave the current standards in place.

MTBE

We are disappointed by the lack of a standard for Methyl tert-butyl ether (MTBE). Although it was proposed during the 2000-2003 Triennial Review, in light of actions by the General Assembly in 2005 to ban the use of MTBE, we feel this is an appropriate time to revisit creating a MTBE standard for surface waters.

MTBE is a chemical that was first added to gasoline to boost octane levels in fuels as a replacement for lead. Although all of the health effects of the additive are not fully known, the EPA considers MTBE a potential human carcinogen at high levels. Additionally, even at low levels, MTBE-exposure has led to reports of nausea, vomiting, dizziness, headaches, and eye, nose, and throat irritation. Even in very small quantities, MTBE makes water undrinkable because of its harsh turpentine-like taste and odor. MTBE also biodegrades slowly and moves rapidly through water, making clean up even more difficult.

It is troubling that North Carolina has not established surface water standards for MTBE as leaking petroleum storage tanks and pipelines can contaminate groundwater and surface water. Considering that MTBE is a potential carcinogen and is harmful enough to have been banned in North Carolina, as well as more than 20 other states, we ask that you implement a standard of 12 ug/L, as was previously recommended for water supplies, to all fresh and salt waters.

METHYLMERCURY

We are greatly concerned about methylmercury and encourage the department to include the adoption of a methylmercury standard during this triennial review. Instead of waiting additional years until the next triennial review, a standard needs to be adopted as the federal recommendations are finalized. The EPA is currently accepting comments on guidance for using the EPA's fish tissue based methylmercury criterion to develop water quality standards. This gives the state a framework from which to develop up to date water quality standards for this widespread pollutant.

North Carolina's power plants emit up to 70 percent of the mercury that pollutes our state's waterways. Mercury undergoes a series of chemical transformations that result in methylmercury, which has resulted in mercury-related fish consumption advisories that, for some types of fish, cover the entire state.

People are primarily exposed to methylmercury by eating contaminated fish and shellfish. In North Carolina alone, the fish consumption advisory issued by the state Division of Public Health includes largemouth bass caught statewide, as well as almaco jack, banded rudderfish, canned white tuna, cobia, Crevalle jack, greater amberjack, South Atlantic grouper, king mackerel, ladyfish, little tunny, marlin, orange roughy, shark, Spanish mackerel, swordfish, tilefish, and tuna. In addition to the statewide advisory, high mercury levels have been found in freshwaters south and east of Interstate 85 in blackfish (bowfin), catfish, jack fish, and warmouth.

Methylmercury is easily absorbed into the tissue of aquatic organisms and builds up in predator fish. This contamination is a particular problem for pregnant women and women of child bearing age because of the damaging effects methylmercury has on young children. Exposure to mercury can cause attention and language deficits, impaired memory, and impaired visual and motor function in children.

The harm caused by methylmercury and the abundance of fish consumption advisories issued in the state make methlymercury a serious concern for North Carolinians. We need to set surface water standards for this pollutant as soon as possible and should not wait until a future triennial review.

Thank you again for the opportunity to submit comments on the proposed changes to the surface water quality standards.

Sincerely,

Christine Wunsche
Clean Water Attorney
Environment North Carolina

Grady McCallie
Policy Analyst
North Carolina Conservation Network

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Raleigh Field Office
Post Office Box 33726
Raleigh, North Carolina 27636-3726

September 1, 2006

Ms. Connie Brower
North Carolina Division of Water Quality
Planning Section
1617 Mail Service Center
Raleigh, North Carolina 27699-1617

Dear Ms. Brower:

The U.S. Fish and Wildlife Service (Service) has reviewed the North Carolina Division of Water Quality's (DWQ) proposed changes to surface water quality standards from the 2004-2006 Triennial Review. The proposals would amend the States' *Classifications and Water Quality Standards Applicable to Surface Waters and Wetlands of North Carolina* (15A NCAC 2B .0200). We provide the following technical assistance comments in accordance with the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.).

The new and revised water quality standards which emerged from the Triennial Review include 1) replacement of the term "dietary intake" with the term "relative source contribution" to account for other chemical exposures when deriving human health standards; 2) changing the fish consumption rate to the national default rate; 3) amended standards for several chemicals based on the aforementioned changes to the calculation procedures; 4) amended standards for benzene and vinyl chloride based on new cancer potency factors; 5) the addition of *enterococci* as a bacterial indicator for coastal waters; and 6) revised cadmium and tributyltin water quality standards for the protection of aquatic life based on recent U.S. Environmental Protection Agency (U.S. EPA) water quality criteria documents.

The Service is in general supportive of the proposed changes. The proposed change in the freshwater quality standard for cadmium to 0.16 µg/L (part per billion, or ppb) from 0.4 ppb in trout waters and 2.0 ppb in non-trout waters is consistent with the U.S. EPA's *2001 Update of Ambient Water Quality Criteria for Cadmium*. Because some have expressed concerns that analytical methods cannot routinely achieve a method detection limit (MDL) or method quantitation limit (MQL) as low as 0.16 ppb, we felt it important to provide information on that issue. The Service uses several different labs for analytical support, and a recent check with five of those labs indicated all five were comfortable with achieving a MDL for cadmium in water or wastewater of < 0.16 ppb. The labs indicated analyses by graphite furnace atomic absorption or inductively coupled plasma/mass spectrometry (ICP/MS). While labs calculate MDLs and MQLs differently, getting below 0.16 ppb cadmium should not be a problem, at least with ICP/MS for which instrument detection limits are typically in the sub parts per billion range (http://www.epa.gov/epaoswer/hazwaste/test/pdfs/6020.pdf). There is more involved in deriving MDLs and MQLs than the instrumentation, but the experience of labs we use is that ICP/MS analyses (for which there are very few interferences for cadmium) can achieve MDLs and MQLs less than 0.16 ppb for cadmium (an element for which there are fewer lab contamination problems than some other elements). We realize MQLs will vary by lab, method, and instrumentation.

The numeric water quality standard for tributyltin is proposed to be raised (i.e., allowing more of the butyltins in the State's waters) from 0.008 ppb to 0.07 ppb (freshwater) and from 0.002 ppb to 0.007 ppb (saltwater). These changes are also consistent with the U.S. EPA's *2003 Ambient Aquatic Life Water Quality Criteria for Tributyltin.* We note that the criteria document discusses some studies reporting adverse effects to biota at concentrations less than the final recommended water quality criteria. The document states that adverse effects in certain aquatic gastropods begin to occur at 0.003 ppb (saltwater), which is closer to DWQ's current tributyltin standard of 0.002 ppb than the proposed change to 0.007 ppb. While the Service does not object to the DWQ's proposed revisions, there is toxicological evidence that would support leaving the 15A NCAC 2B tributyltin standards unchanged, and that should be considered.

The Service has previously provided DWQ with published results of freshwater mussel toxicity data indicating the sensitivity of mussels to ammonia. We suggested development of an ammonia standard during the 2000-2003 Triennial Review. Mussel toxicity data for ammonia are reliable and mussels routinely rank among the more sensitive organisms to ammonia. There are ample data for developing a standard for this common pollutant, and we encourage DWQ to pursue a standard for North Carolina, a State with a rich diversity of freshwater mussels (over 50 species of freshwater mussels are native to North Carolina). The toxicity of ammonia, its common occurrence in waters, and its importance as a potential limiting factor for freshwater mussels point to the utility of a standard to more effectively manage this pollutant. The Service would be pleased to help DWQ and other stakeholders work on this issue.

We appreciate DWQ's efforts to seek and synthesize input on this Triennial Review. Should you have questions or would like to meet to discuss our comments, please contact Tom Augspurger of our staff at 919/856-4520 x.21.

Sincerely,

Tom Augspurger

for Pete Benjamin
Field Supervisor

cc: Gordon - USEPA, Atlanta
Starkel - FWS, Atlanta

SOUTHERN ENVIRONMENTAL LAW CENTER
200 WEST FRANKLIN STREET, SUITE 330
CHAPEL HILL, NC 27516

Telephone 919-967-1450
Facsimile 919-929-9421
selcnc@selcnc.org

Charlottesville, VA
Chapel Hill, NC
Atlanta, GA

September 1, 2006

Connie Brower
DENR/Division of Water Quality Planning Section
1617Mail Service Center
Raleigh, NC 27699-1617
Connie.brower@ncmail.net
FAX (919)715-5637

VIA FACSIMILE and Electronic Mail

RE: 2004-2006 Triennial Review of Surface Water Quality Standards

Dear Ms. Brower:

The Southern Environmental Law Center submits these comments on the Division of Water Quality's (DWQ) proposed rule amendments to the surface water quality standards contained in the 15A N.C.A.C. 02B regulations. We commend DWQ's efforts to update these standards and support the recommended changes updating the current fish consumption rate, adopting enterococci as the new recommended bacterial indicator for coastal waters, and providing a more protective standard for cadmium, heptachlor, hexachlorobutadiene, and trichloroethylene. We are concerned, however, by the proposed relaxing of the tributyltin standard and the omission ammonia and methyl mercury from the 2006 triennial review process. Each of these concerns is explained in more detail below.

Tributyltin

Tributyltin is an extremely toxic chemical used as a biocide. According to the Pesticide Action Network website, tributyltin is currently used in 34 active biocide products in the United States. These products are used in applications such as treatment for slime-forming fungi in water cooling towers, paper mills and water systems and as an antifouling agent in marine paints.[1] According to Pesticide Action Network and EPA, tributyltin is an endocrine disruptor and extremely toxic to aquatic life. In addition, once it is released to the environment, it is stable and resistant to natural degradation in water. Because tributyltin is so toxic to aquatic life and resistant to degradation, we are especially concerned that DWQ is proposing to weaken the tributyltin standard.

[1] Pesticide Action Network information on tributyltin, *at* http://www.pesticideinfo.org/Detail_Chemical.jsp?Rec_Id=PC4

Tributyltin bioaccumulates in many aquatic organisms[2] causing a range of problems, including altering development, genetics, and growth; and causing injury and mortality. Some species bioaccummulate tributyltin more readily and suffer greater effects from tributyltin exposure. For example, in some marine snails, imposex (the imposition of male reproductive organs on females) can be caused by concentrations of tributyltin as low as 1 ng/l.[3] Of particular concern for North Carolina's aquatic resources, both trout and oysters are susceptible to deleterious effects from low tributyltin exposure. Rainbow trout appear to bioacumulate tributyltin by a factor in the thousands[4] and even low levels impair growth and blood and liver metabolism. Tributyltin oysters suffer from abnormal shell development, poor weight gain, brittle shells, and imposex. Tributyltin has also been implicated as a contributor to outbreaks of disease in Eastern oysters because it suppresses the oyster immune system.[5]

Considering the sensitivity of North Carolina's freshwater and marine aquatic life to tributyltin and the importance of these resources for tourism and industry, we urge the Division of Water Quality to retain the more stringent standard.

Methylmercury

We strongly encourage the Division of Water Quality to revise the methylmercury standard to include a fish tissue standard. Methylmercury is more toxic than elemental mercury and most people are exposed to it through the consumption of contaminated fish and shellfish. Methylmercury is a neurotoxin and can adversely affect the brain and nervous system.

EPA finalized the criterion for methylmercury in January 2001.[6] At that time, EPA concluded that it is more appropriate to adopt a fish tissue (including shellfish) residue criterion for methylmercury rather than a water column-based criterion because the it integrates spatial

---

[2] *See e.g.*, Yamada, Hisashi; Takayanagi, Kazufumi, Bioconcentration and elimination of bis(tributyltin)oxide (TBTO) and triphenyltin chloride (TPTC) in several marine fish species, Water Research. Vol. 26, no. 12, pp. 1589-1595. 1992 (stating that the bioconcentration factor for tributyltin ranged from 2400 to 11,000 depending on the fish species and the concentration in the rearing seawater.).

[3] *See e.g.*, C Alzieu, *Impact of tributyltin on Marin Invertebrates*, Ecotoxicology, Vol. 9, April 2000 (stating "[a]t concentrations close to 1 $ng \cdot l^{-1}$, significant changes are observed in the sexuality of marine gastropods, reflected in an imposition of male characters in females, a phenomenon known as imposex.);

Bryan, GW; Gibbs, PE, *Impact of Low Concentrations of Tributyltin (TBT) on Marine Organisms: A Review*, Metal Ecotoxicology: Concepts and Applications. Advances in Trace Substances Research Series. Lewis Publishers, Inc., Chelsea, Michigan. 1991. p 323-361. 1 fig, 5 tab, 134 ref. (stating that "[e]xperimental and field observations have shown that some mollusks are sensitive to seawater TBT levels below 10 ng/L. In neogastropods, imposex is induced in the females of several species at concentrations of no more than a few nanograms per liter. Female Nucella lapillus are sterilized at concentrations below 10 ng/L. Shell malformation in the Pacific oyster, Crassostrea gigas, occurs over a similar range of concentrations.")

[4] EPA, Final Ambient Aquatic Life Water Quality Criteria for Tributyltin (TBT) (2003) (stating that "BCF/BAF factors in the thousands for rainbow trout, *Oncorhynchus mykiss*, where TBT concentrations were approximately 1.0 µg/L").

[5] *See* W. S. Fisher, L. M. Oliver, W. W. Walker, C. S. Manning, T. F. Lytle, Decreased resistance of eastern oysters (Crassostrea Virginia) to a protozoan pathogen (Perkinsus marinus) after sublethal exposure to tributyltin oxide, Marine Environmental Research, March 1999 (stating "results indicated increased infection intensity and oyster mortality in the TBT-exposed treatments relative to unexposed controls.").

[6] EPA, Water Quality Criterion for the Protection of Human Health: Methylmercury, EPA-823-R-01-001 (January 2001).

and temporal complexity that occurs in aquatic systems and that affects methylmercury bioaccumulation.[7]

North Carolina currently has a water column-based water quality standard for methylmercury of 0.012 ug/l,[8] but does not utilize a fish tissue water quality standard. Because of the significant risk that mercury poses to human health, we strongly encourage the adoption of an adequate methylmercury standard as soon as possible

Ammonia

We strongly urge the development of a water quality standard for ammonia in this triennial review. The state of North Carolina does not have a water quality standard for ammonia, despite the fact that ammonia is known to be toxic to fresh water mussels.

Freshwater mussels are the largest group of endangered animals in North America.[9] North Carolina is home to more than 60 species of freshwater mussels and, unfortunately, 50% of these species are designated endangered, threatened, or special concern within the state. Five federally and state listed endangered mussels live throughout North Carolina—Appalachian elktoe (*Alasmidonta raveneliana)*, Carolina Heelsplitter *(lasmigona decorata)*, dwarf wedgemussel (*Alasmidonta heteradon*), littlewing pearlymussel (*Pegias fabula*), and the Tar River spinymussel (*Elliptio steinstansana*).

Ammonia can enter surface waters from many sources, including runoff polluted with fertilizer, leaching septic tanks, and from agriculture operation emissions. Current research on the effects of ammonia on mussels demonstrates that freshwater mussels are sensitive to ammonia at both chronic and acute levels of exposure. Chronic ammonia impacts to freshwater and marine bivalves include reduction of respiration and feeding; depleted carbohydrate stores; and altered metabolism.[10] Acute toxicity or mortality for freshwater bivalves has also been demonstrated.[11] Because ammonia has a significant impact on one of North Carolina's most important resources, we strongly recommend that DWQ develop a water quality standard for ammonia that will protect these severely threatened species.

---

[7] *Id.*

[8] N.C. Admin. Code. tit. 15A, r. 02B.0211(l(ix) (2005).

[9] United States Geological Survey (USGS), *Effects of ammonia on freshwater mussels in the St. Croix River*, Fact Sheet FS 2004-3046, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin (2002) (detailing a 3 year study on the effects of ammonia on native mussels and showing ammonia to be lethal to juvenile mussels at concentrations as low as 93µg/L, and that growth rates were substantially affected at 31 µg/L.).

[10] *See* A.K. Mummert, R.J. Neves, T.J. Newcomb, and D.S. Cherry, *Sensitivity of juvenile freshwater mussels (Lampsilis fasciola, Villosa iris) to total and un-ionized ammonia*, ENVIRONMENTAL TOXICOLOGY AND CHEMISTRY 22:2545-2553 (2003).

[11] *See* T.J. Newton, J.W. Allran, J.A. O'Donnell, M.R. Bartsch, and W.B. Richardson, *Effects of ammonia on juvenile unionid mussels (Lampsilis cardium) in laboratory sediment toxicity test,* ENVIRONMENTAL TOXICOLOGY AND CHEMISTRY 22:2554-2560 (2003); Tom Augsberger, et. al., *Water Quality Guidance for Protection of Freshwater Mussels (Unionidae) from Ammonia Exposure*, ENVIRONMENTAL TOXICOLOGY AND CHEMISTRY, Vol. 22, No. 11, pp. 2569–2575 (2003).

Conclusion

We appreciate the opportunity to submit these comments and respectfully request that the proposal to weaken tributyltin be eliminated and that adequate protection from both methylmercury and ammonia be developed.

Sincerely,

Amy Pickle
Staff Attorney
Southern Environmental Law Center

September 1, 2006

Ms. Connie Brower
DENR Division of Water Quality/Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617
Connie.brower@ncmail.net

Dear Ms. Brower:

Clean Water for North Carolina (CWFNC) and the undersigned NC riverbasin organizations are pleased to submit the following comments in for the 2004-2006 NC Triennial Review of Water Quality Standards.

Comments on the Amendments to the NC Water Quality Standards Proposed by NC Division of Water Quality:

We are supportive of the work of the DWQ Planning Section in preparing for rulemaking for new or more protective general surface water quality standards for a number of toxic substances including benzene, beryllium, cadmium, DDT, dioxin, PCBs, PAHs, and vinyl chloride (15A NCAC 02B .0208 – Toxic Substances and Temperature). These are all highly toxic substances and we applaud DWQ's efforts to set more restrictive standards for these pollutants.

We support the substitution of enterococci for use as indicator bacteria and the prohibition of mixing zones for dischargers of enterococci in SA and SB waters. It should be noted that we continue to regard the presence of implicit or explicit mixing zones as an abdication of the Division's responsibility to set discharge limits in NPDES permits that are fully protective of a resource from the point of discharge.

We also support the revision to calculation of the fish tissue and water consumption for derivation of health based water quality standards.

However, we are opposed to the proposed weakening of limits for trialkytin compounds for class C waters, and for weaker limits for both beryllium (from 6.8 to 7 ng/l) and chlordane (0.575 to 0.8 ng/l) for all water supply watersheds (WSI, WSII, WSIII, WSIV and WSV waters).

Additional Proposed Parameters for NC In-stream Standards:

Color

In addition to the changes proposed for the 2004-2006 Triennial Review, we strongly urge DWQ to adopt a NUMERICAL standard for color. NC's current narrative standards for color and other aesthetic parameters, with no numeric equivalents or surrogates, do not hold polluting facilities accountable for the economic, biological and quality of life impacts of their discharges. These narrative standards also have not been used by NC DWQ to list waters impaired for recreational or other uses. Dr. David Moreau, Chair of the EMC, repeatedly pointed out during the October, 2001 variance hearing for Blue Ridge Paper Products, that it is functionally impossible to judge the need for a variance, or progress toward its removal, without a numerical standard for color.

Furthermore, according to guidance from EPA's "Gold Book" of Quality Criteria for Water (1986), ". . . waters shall be virtually free from substances producing objectionable color for aesthetic purposes." The Gold Book also states that "Water should be virtually free from substances introduced by man's activities which produce objectionable color." The term "objectionable color" is defined in the Gold Book to be "a significant increase over natural background levels. Non-natural colors such as dyes should not be perceptible by the human eye as such colors are especially objectionable to those who receive pleasure by viewing water in its natural state."

The 1962 Drinking Water Standards (PHS, 1962) recommended that color in finished waters should not exceed 15 units on the platinum-cobalt scale. Water consistently can be treated using standard coagulation, sedimentation, and filtration processes to reduce color to substantially less than 15 color units when the source water does not exceed 75 color units (AWWA, 1971; NAS, 1974).

The EPA's Gold Book also states that 25 color units should be the *maximum* value used as a source of water for the petroleum industry and that, through treatment, waters can be made to meet almost any industrial requirement. Yet DWQ continues to allow certain industries to create conditions much worse than this by their discharge to state waters.

We propose the following strategy for implementing an even-handed regulatory regime for color discharges:

1) Characterizing each discharge's visible color spectrum, determining the wavelength of maximum absorbance (or multiple wavelengths for discharges with several different colored discharges). While 465 nm is the standard wavelength for regulating pulp mill discharges, the spectrum we have obtained shows that this is not the wavelength of maximum absorption. In fact, the strong absorbance in the shorter wavelengths and near UV probably indicates the presence of uncharacterized aromatic organics, indicative that the overall color may be associated with general toxicity not being currently captured by WET testing requirements.

2) Instream true color standard for each permitted facility would be regulated, within 100 feet downstream of the discharge, at the % opacity (absorbance) equivalent of 25 platimum-cobalt "true color" units increase over the absorbance at 465 nm of a filtered sample of upstream water at that wavelength. For "blackwater" streams, a 30% increase in absorbance would allow more color discharge without aesthetic damage. For clearwater streams (usually 5-20 color units), an increase of no more than 100% of absorbance from the average upstream measurement should be allow and enforced on a daily basis (ie, any measurement that is greater than 100% increase in color would be a violation for that date). Therefore, if EPA judges the maximum acceptable color to be 25 units, the increase due to any discharge into a clear water stream shall not exceed 25 color units.

3) Apparent color, measured as the absorbance of an unfiltered, unsettled sample downstream of effluent, must be limited at 1.5 times the opacity limit of the filtered sample, compared to a filtered upstream sample.

Spectroscopic measurements on an inexpensive spectrophotometer require only 15 minutes per colored surface water sample. Once the spectrum has been characterized, measurements at a small number of wavelengths will require even less time and essentially no expense. North Carolina has avoided regulation of color in order to protect industrial facilities from regulatory accountability, but this analysis is so simple and inexpensive, there is simply no reason not to implement such a standard very quickly. Numerous waters, including the Pigeon River, South Fork of the Catawba, Third Creek in Statesville and others, have been impaired by color, rendering them unusable for fishing, swimming, irrigation or other uses.

MTBE

During previous attempts to set a health based surface water and groundwater quality standard for methyl tertiary-butyl ether (MTBE), the petroleum industry, the sole source of this synthetic pollutant, has lobbied Environmental Management Commissioners intensely to prevent setting a standard that could create additional liability for clean ups to safe standards. As North Carolina joins 20 other states in phasing out the use of MTBE on the basis of its potential carcinogenicity and its inherent ability to dissolve and spread rapidly through water, it is long past time to establish a standard no higher than 12 ug/l for all surface waters and groundwater.

Conductivity

In addition to the need for a numerical color standard, North Carolina also needs a state standard for conductivity. According to the EPA and other experts, conductivity is useful as a general measure of stream water quality. It can be used to detect how many impurities are dissolved in the water. Studies carried out at UNC-Asheville indicate inland fresh waters that are healthy and support healthy fisheries range between ~100 and 500 uS/cm. Conductivity outside this range could indicate that the water is not suitable for certain species of fish or macroinvertebrates, and can present an additional stressor when discharges include elevated temperatures, color or other pollutants.

Currently there is no water quality index for various waters associated with conductivity, although some values may be better than others for a particular body of water since the geology of the area can affect the natural conductivity of a given water body. However, each waterway has a relatively constant range of conductivity that, once established, can be used as a baseline for comparison with regular conductivity measurements. Regular monitoring may reveal abrupt changes in conductivity, which might indicate that water or wastes are being diverted into the stream from an outside (or unregulated) source. Monitoring would be very affordable, as hand held meters cost only around $350 dollars. Therefore, we recommend establishing a state standard for conductivity, restricting facilities that discharge to a given waterway to elevating conductivity levels to no more than 200% of the average upstream levels (ie, no more than 100% increase above the upstream average).

Radioactivity
There is a complete lack of discharge limits for radioactivity specified in NPDES permits for nuclear power generation facilities, (including tritium, combined radium-226/228, and alpha and beta emitters). Even though North Carolina has health-based radioactivity standards for both surface water quality and public drinking water supplies, actual limits on radioactive substances appear nowhere in the monitoring parameters of the NPDES permits for nuclear power plants in our state. North Carolina's standards for radioactivity are in some cases more protective than federal standards, but they must be specifically implemented through monitoring requirements and public reporting through discharge monitoring reports, and regulation by DWQ, rather than simply reporting to the Nuclear Regulatory Commission. In addition, permits for all nuclear facilities must include ambient monitoring, with public reporting of results in DMRs, in the vicinity of all nuclear power stations and spent fuel storage.

Ammonia
It is critical to strengthen standards for ammonia in ambient waters to better protect aquatic life, particularly mussels. Currently, according to DWQ's "Redbook," ammonia toxicity "shall be evaluated according to EPA guidelines promulgated in 'Ambient Water Quality Criteria for Ammonia – 1984; EPA document number 440/5-85-001; NITS number PB85-227114; July 29, 1985 (50 FR 30784) or 'Ambient Water Quality Criteria for Ammonia (Saltwater) – 1989.'" However, recent peer-reviewed research indicates that current federal and state standards for ammonia appear to be too weak for mussels.

The U.S. EPA water quality criteria for ammonia were derived from a toxicity database created prior to the relatively recent availability of data for freshwater mussels. The attached article (Augspurger, Keller, Black, Cope, and Dwyer) indicates that sufficient data seems to exist to support revision of the U.S. EPA acute ammonia criteria or establishment of state water quality standards for acute exposure. Freshwater mussel data are not included in the current database for calculation of the US EPA water quality criteria for ammonia. More recently data indicate that freshwater mussels are sensitive to ammonia relative to other invertebrates and fishes and that the current numeric criteria may not be protective of mussels - more than half of whose nearly 300 species are in widespread decline in North America.

Manganese
Given a growing body of knowledge regarding the health impacts of Mn exposure, NC must set a surface water standard of 50 ug/l, consistent with our state's 2L standards, reflecting the potential for exposures through ingestion while swimming or other activities.

Mercury in surface water and sediments
This contaminant will seldom be found in detectable quantities in the water column, and is listed as an impairment only because of fish advisories. Mercury will need to be monitored in sediments at risk in order to track its impact on the aquatic environment, rather than simply being included as a surface water standard. For all persistent, bioaccumulative toxins, there is no assimilative capacity and amounts of these substances

add to the environment will be cumulative, so there must be a goal of zero discharge in all permits and a concentration of zero in the water column.

As is well known, the original source of nearly all mercury (and its most toxic transformed species, methylmercury) is industrial air emissions, particularly from coal fired power generation. Therefore, DWQ must aggressively pursue, along with the Dept. of Health and Human Services, and Division of Air Quality, the setting and implementation of inter-media standards for mercury and its compounds that will quickly stop their atmospheric distribution and subsequent bioaccumulation in our waters, sediments and fisheries. Each month of delay in carrying out this critical inter-agency mission for the public is a failure to prevent an ongoing crime against the health, well-being and intellectual function of future generations.

Dioxin in sediments
For current permitted discharges, dioxins and other bioaccumulative toxins must be regulated at non-detect in effluent, including the permit condition that the most sensitive EPA approved analytical method be used. Historic dioxin/furans in sediments must be comprehensively monitored at least every three years by the NC Division of Water Quality and Div. of Waste Management's Superfund Branch, including portions of the Roanoke and Pigeon Rivers downstream from major historic dioxin discharges. If risk to aquatic and human health from fish consumption is not predicted to reduce to 10^{-6} for cancers or other major health risks within 5 years, the site **must** be added to the NPL for removal or active remediation.

Adsorbable Organic Halides (AOX)
While this parameter is now regulated in pulp mill effluents by the industry Cluster Rules now in implementation, as a weight/weight ratio with total tons of pulp production, this is inadequately protective of small receiving waters, and their protected uses. In addition, these diverse compounds include many chemical species that are bioaccumulative, mutagenic or carcinogenic, or otherwise toxic and should therefore be regulated instream at non-detect as well as "at the pipe" using a rigorous AOX effluent loading standard which places all pulp mills on a level regulatory playing field.

<u>Proposed Changes to Primary and Supplemental Surface Water Classifications</u>

Class C Waters
No classification of waters should be less than fully protective of human health, including complete immersion for recreation or any reason. Therefore we call for all classifications to include standards protective of aquatic habitat and swimming, whether or not the streams are actually meeting those designated uses. Class C waters have been colloquially referred to as "industrial waters" by the water advocacy community because these rivers and streams have been treated mainly as disposable resources for economic development or disposal of wastes. Historically, the only difference between Class C and Class B waters has been the requirement for dischargers to have back-up systems to prevent bacterial threats to human health. The Division of Water Quality has

acknowledged that the bacterial standard, as currently implemented for Class C waters (and we believe that there are other parameters which should be included in this consideration), is NOT protective of human health during swimming or other public uses. We therefore urge you to **eliminate the category of Class C waters, and to reclassify segments as Class B, including standards fully supporting all uses required by the Clean Water Act, and listing them as impaired if not fully supporting their designated uses.**

Region 7 EPA reviewed the standards and classifications proposed by the state of Missouri. EPA officials responded to the Missouri Department of Natural Resources in a September, 2000 letter: "Section 101(a)(2) of the CWA calls for the designation of aquatic life and recreational uses for all waters of the US, where attainable. EPA's regulations require the state to perform and submit to EPA for approval a Use Attainability Analysis whenever the state does not designate waters for aquatic life and recreational uses. Without an approvable use attainability analysis for each water not designated for CWA section 101(a)(2) uses, (i.e. aquatic life and whole body contact uses), these new or revised use designations must be disapproved."

Region 7's letter then details the justification for this mechanism to fulfill the intent of the Clean Water Act: "The "use" of a water body is the most fundamental articulation of its role in the aquatic and human environments, and all of the water quality protections established by the CWA follow from the water's designated use. If a use lower than "fishable/swimmable" is designated based on inadequate information or superficial analysis, water quality based protections that might have enabled the water to achieve the goals articulated by Congress in section 101(a) may not be put in place. As a result, the true potential of the water body may never be realized, and a resource highly valued by Congress may be forever lost."

Furthermore, our North Carolina advocacy groups would point out the failure to include standards for classifications that are protective of those uses will do nothing to prevent the degradation of streams and rivers that ARE currently supporting the intended uses, thus violating the Clean Water Act's basic prohibitions against antidegradation of waters.

Region 7 officials then point out an important parallel to North Carolina's historical approach to this issue: " MDNR's philosophy since 1967 has been to withhold the designation of surface waters for whole body contact unless requested by the public...Without the necessary use attainability analysis, the State's failure to meet the requirements of section 101 (a)(2) of the CWA and its implementing federal regulations has and continues to be a significant deficiency within Missouri's water quality standards program."

Finally, Region 7 gives Missouri officials warning that they must promptly revise their standards to be fully protective. "Unless the State makes the proposed changes within 90 days of receipt of this letter, EPA Region VII will be requesting that the Administrator make a finding that Missouri's failure to adequately justify a use designation lower than a "fishable/swimmable" for all classified waters of the State that currently lack whole body contact use designation is contrary to the requirements of the CWA, and that a promulgation action to correct this deficiency be initiated."

We ask that the NC Division of Water Quality not continue to place our state's rules in conflict with the clear intentions of the Clean Water Act as previously interpreted by EPA Region 7. We call for the complete elimination of Class C Waters or the promulgation of a set of standards that will fully protect all of our waters as "swimmable/fishable."

Wetlands Classifications

In light of the recent SWANCC Supreme Court decision that appears to remove protection from isolated wetlands, DWQ should aggressively designate isolated wetlands and provide them with the appropriate classification from the following options. We call for implementation of more protective classifications for our wetlands, including:

- Class WL – Freshwater Wetlands – This classification should denote areas that are wet for some or all of the year, and support vegetation adapted to life in soils saturated with fresh water. The Classifications and Standards Unit states that "these waters are protected for storm and flood water storage, aquatic life, wildlife, hydrologic functions, filtration, and shoreline protection." CWFNC agrees with the Division of Water Quality that freshwater wetlands could and should provide these critical functions. Unfortunately, this designation carries no restrictions on development or wastewater discharges. What is even worse, this category is not currently applied to any water bodies in North Carolina. This classification should be given to freshwater wetlands across the state, and should include the following restrictions:
    1. No wastewater lagoons or spray fields for disposal of agricultural wastes or wastewater.
    2. Stormwater controls, such as those as required under CAMA.
    3. No new general discharge permits, only individual permits for any discharges. Existing general discharge permits should be changed to individual permits at their next permit review.
    4. Freshwater wetlands should be High Quality Waters by definition, and receive similar controls.

- Class SWL – Saltwater Wetlands – This classification should denote areas which are wet for some or all of the year, and support vegetation adapted to life in soils saturated with salt water or brackish water. North Carolina's coast contains large saltwater wetland areas, including estuaries, tidal flats, and saltwater marshes that are critical for ecological and economic values. The Division of Coastal Management has identified Coastal Wetlands, which should be very similar to this classification. In addition to the restrictions established by DCM, DWQ should recognize these areas as Saltwater Wetlands. These areas should be considered High Quality Waters by definition, and should receive protections analogous to those of HQW streams.

- Class UWL – Unique Wetlands – This classification should serve as a wetlands analogue of Outstanding Resource Waters (ORW). A site should qualify as Unique Wetlands based on similar requirements of ecological or recreational significance. A Unique Wetlands designation should contain the same prohibition on new or expanded discharges and development controls as ORWs.

Perhaps part of the reason for allowing this classification to languish is that the Army Corps of Engineers already requires permits for activities that damage wetlands. However, federal oversight does not guarantee protection of NC's wetlands. The Corps has an abysmal record of protecting wetlands from development, and recently announced new guidelines backing away from the policy of "no-net-loss" of wetlands. A recent Supreme Court decision restricted the scope of the Corps' jurisdiction. Furthermore, the Corps focuses on activities that dredge and fill wetlands, but does not consider the environmental impacts of discharges into wetlands. For all of these reasons, it is important that North Carolina act aggressively, consistent with the ruling of the Environmental Management Commission for protection of isolated wetlands, to protect its diverse wetlands by implementing these higher quality wetlands classifications.

Waters Impaired for Two or More Pollutants

The Clean Water Act requires the listing of any water that is failing to meet its designated uses as impaired for every pollutant. We believe the Division is failing to list waters for more than one pollutant in several cases, with the result that improvement in level of one pollutant may result in delisting a water before other pollutant impacts have been sufficiently reduced to allow fulfillment of designated uses. This is particularly the case for pollutants for which the Division has not set numerical standards or developed a methodology for evaluation.

Variances to WQ Standards

The state must review all of its current variances, most notably for temperature and color, including providing rigorous criteria for evaluating the economic need and the biological and economic consequences for granting or continuing them. Variances must not be granted for perpetuity or an indefinite period. The Triennial Review is a critical opportunity for those agency personnel more removed from the permitting process and its pressures to set objective standards for review and implementation of appropriate water quality improvements, and we are deeply disturbed by comments from staff that the real review will come only in the context of permit renewal for the specified facilities. In fact, we have seen little evidence that such considerations are critically reviewed in terms of setting any permit conditions for continuing improvements in water quality and aquatic habitat.

Variances to water quality standards are, functionally, an agreement by the state to accept the continued impairment of a water body. No future variances to water quality standards should be granted unless there is a clear set of objective criteria to weigh the need to protect the public's water with economic needs, and specified variance conditions requiring that any permitted discharge resulting in a variance will be treated as it would under a TMDL. Permittees must be held accountable by enforceable permit provisions for approved methodologies to study the biological impacts of their discharges. The implementation plan for removal of a variance must include a review of all technologies able to reduce pollutants from discharges and a stipulated schedule for progress. Failure to make such progress must result in removal of the variance and permit revocation.

Temperature Variances

At the time of the previous Triennial Review, we called for a comprehensive study of instream conditions related to all of the state's temperature variances (including Blue Ridge Paper and numerous coal and nuclear power generation facilities) to be carried out before the next review of water quality standards, so that the EMC could judge the legality of those variances. In the case of Blue Ridge Paper, we contend that the temperature variance is illegal because a balanced and indigenous species population does not exist below the mill's discharge. We expect that on close study, this will also be true of several, if not all, of the other temperature variances granted to power stations.

Section 316 of the Clean Water Act requires effluent limitations on thermal discharges that "will assure protection and propagation of balanced, indigenous population of shellfish, fish, and wildlife." **A variance from existing standards is only allowed in the event that the standards are more stringent than necessary to assure the protection and propagation of balanced, indigenous population of shellfish, fish, and wildlife.**

Based on previous balanced and indigenous species studies, and the opinions expressed by DWQ's own Biological Assessment Unit, we are convinced that a balanced and indigenous species population does not exist in the Pigeon River below the mill's discharge. Through the years DWQ and permittees have argued on various grounds as to why the temperature variance is legal, including that other pollutants from the mill obscure the impact of temperature, and that the mill is located in a transitional zone. Such claims by the senior officials of DWQ are inconsistent with DWQ's own Biological Assessment Unit that believes thermal preferences are a "cause for the longitudinal restriction of cool water species that are found above the mill but not below it."

Merely requiring that the permitted entity conduct a study as a condition of the variance is not adequate and is contrary to DWQ's promise to EPA for the Champion International permit renewal in 1996. In DWQ's 10/01/96 response to EPA's comments on the 1996 draft permit, DWQ stated: "...the temperature variance will be reviewed more thoroughly during the next permit renewal with pre-established periods of record and simulations." This is essentially the same claim being made in this permit. Clear and specified operating conditions must be included in the permit to hold the facility accountable for temperature excursions (such as those noted in Blue Ridge Paper discharge monitoring reports for recent years, including discharge temperatures in excess of 100 degrees F) as well as specific criteria to actually determine whether or not these variances are legal. Furthermore, all such studies must be conducted by an entity that is certified by NCASI and agreeable to the EMC.

Finally, since a variance is an acknowledgment of an impact that would be disallowed under water quality standards, both the temperature performance of a facility <u>and</u> the resulting biological conditions must show significant improvement (the greater the impairment, the larger the percentage improvement that should be required) toward removal of the variance with each renewal, or the variance must be terminated.

Thank you for the opportunity to submit these comments for NC's 2004-2006 Triennial Review.

Sincerely yours,

Gracia O'Neill and Hope Taylor-Guevara, Clean Water for North Carolina
Hartwell Carson, French Broad Riverkeeper, Riverlink
Dean Naujoks, Nuese River Foundation
Phillip Gibson, former French Broad Riverkeeper
Heather Jacobs, Pamlico-Tar Riverkeeper, Pamlico-Tar River Foundation
Mark Hooper, President, Carteret County Crossroads
Laurel Valley Watch, Madison County NC

A-253
SETAC PRESS
Environmental Toxicology and Chemistry, Vol. 22, No. 11, pp. 2569–2575, 2003
Printed in the USA
0730-7268/04 $12.00 + .00

WATER QUALITY GUIDANCE FOR PROTECTION OF FRESHWATER MUSSELS (UNIONIDAE) FROM AMMONIA EXPOSURE

TOM AUGSPURGER,*† ANNE E. KELLER,‡ MARSHA C. BLACK,§ W. GREGORY COPE,|| and F. JAMES DWYER#
†U.S. Fish and Wildlife Service, P.O. Box 33726, Raleigh, North Carolina 27636-3726
‡U.S. Environmental Protection Agency, Water Management Division, 701 San Marcos Boulevard, Jacksonville, Florida 32207
§Department of Environmental Health Science, University of Georgia, Athens, Georgia 30602, USA
||North Carolina State University, Department of Environmental and Molecular Toxicology, Raleigh, North Carolina 27695-7633, USA
#U.S. Fish and Wildlife Service, 608 East Cherry Street, Columbia, Missouri 65201

(*Received* 18 *July* 2002; *Accepted* 3 *February* 2003)

Abstract—Ammonia toxicity data for freshwater mussels (Unionidae), a significantly imperiled taxa, were used to derive estimates of concentrations that would not likely be harmful in acute and chronic exposures and to assess the protectiveness of current U.S. Environmental Protection Agency (U.S. EPA) water quality criteria to this family of organisms. Thirty acute (24–96-h) median lethal concentrations (LC50s), covering 10 species in eight unionid genera, were used to calculate genus mean acute values (GMAVs) ranging from 2.56 to 8.97 mg/L total ammonia as N at pH 8. Freshwater mussels are at the sensitive end of the range when added to the GMAVs from the database used to derive the U.S. EPA criteria maximum concentration (CMC). We derived two estimates of acute exposure water quality guidance for the protection of freshwater mussels (CMC_{FM}) by a recalculation of the CMC after adding freshwater mussel GMAVs to the U.S. EPA data set. The CMC_{FM}s of 1.75 and 2.50 mg/L total ammonia as N at pH 8 average 60% less than the U.S. EPA CMC of 5.62 mg/L total ammonia as N at pH 8 for application when salmonids are present. These values average about 75% less than the CMC for application when salmonids are absent. No chronic ammonia exposure data existed for unionids. Thus, we applied a range of estimated acute:chronic ratios to the acute toxicity data set, expanded with the freshwater mussel GMAVs, to estimate continuous ammonia concentrations that may be protective of freshwater mussels. These estimates ranged from 0.3 to 1.0 mg/L total ammonia as N at pH 8, about 20 to 75% less than the U.S. EPA criteria continuous concentration (CCC) of 1.24 mg/L total ammonia as N at pH 8 and 25°C. The current numeric criteria for ammonia may not be protective of mussels, more than half of whose nearly 300 species are in decline in North America. While the CMC_{FM} and CCC_{FM} are not equivalent to revised U.S. EPA criteria, they are offered as interim guidance for the protection of freshwater mussels.

Keywords—Ammonia Unionidae Freshwater mussels Water quality criteria

INTRODUCTION

Many factors are cited in the decline of freshwater mussel (Unionidae) populations in North America and for the listing of greater than 70% of native unionids as endangered, threatened, or of special concern [1,2]. Habitat alteration, introduction of exotic species, overutilization, disease, predation, and pollution are considered causal or contributing factors to the decline of mussel populations in many areas of the United States [3–5]. Toxic substances were among the stressors frequently cited as limiting factors for freshwater mussels in a recent survey of experts for this taxa [6]. While mussels appear relatively tolerant to some organic solvents and pesticides [7,8], published toxicological data also indicate that early life stages of freshwater mussels are among the most sensitive aquatic organisms tested for impacts of inorganic chemicals, including chlorine [9], metals [10,11], and ammonia [9,12].

In addition to freshwater mussels' apparent sensitivity to ammonia, this compound is of particular interest as a potential limiting factor in their survival and recovery because it is a common pollutant. Ammonia is a natural degradation product of nitrogenous organic matter; significant sources of enrichment include industrial waste, municipal wastewater treatment plants, and agricultural runoff (animal wastes as well as chemical fertilizers). Sediment pore-water concentrations of ammonia typically exceed those of overlying surface water [13], thereby placing the infaunal (burrowed in sediment) freshwater mussels in the environmental compartment where ammonia concentrations are frequently elevated. For these reasons, ammonia merits priority attention among the many chemicals to evaluate for effects on mussels. The U.S. EPA water quality criteria for ammonia were derived from a toxicity database created prior to the relatively recent availability of data for freshwater mussels. We undertook an evaluation of ammonia toxicity data for freshwater mussels with two goals: to derive estimates of the concentrations that would not be harmful in acute and chronic exposures and to compare those concentrations to U.S. EPA water quality criteria [14] to assess the protectiveness of existing guidance.

METHODS

Development of the ammonia toxicity database

To compile available ammonia toxicity data for freshwater mussels, we reviewed the data set used in the recently revised U.S. EPA water quality criteria document for ammonia [14], searched the Toxline® (U.S. National Library of Medicine, Bethesda, MD) and AQUIRE (U.S. Environmental Protection Agency, Duluth, MN) databases, and queried researchers familiar to us with experience in mussel toxicity testing. Data from our own laboratories were also used.

Because no U.S. EPA or American Society for Testing and Materials standard methods exist that have specifically been

* To whom correspondence may be addressed (tom_augspurger@fws.gov).

developed for freshwater mussel toxicity tests, we evaluated data from all sources for acceptability using guidance modified from the U.S. EPA [15]. Studies that demonstrated acceptable survival in control treatments (≥80%) used measured rather than nominal values for ammonia test concentrations, and documented test water pH and temperature to allow calculation of total and un-ionized ammonia concentrations were deemed acceptable and were used in our analysis.

Data generated by our laboratories generally followed protocols published by us for mussel toxicity tests with other compounds [8]. Static toxicity tests were 24- to 96-h exposures with glochidia or juvenile stages of mussels. Tests were conducted in soft or moderately hard reconstituted water [16]. Exposures consisted of five ammonium chloride concentrations tested in replicates of three to six, with 50 to 100 glochidia or 10 to 20 juvenile mussels per replicate, depending on availability of organisms. A dilution water control was always included for each species. Photoperiod was 16:8 h light: dark; test organisms were not fed during the exposures. Dissolved oxygen, temperature, and pH were measured on each batch of reconstituted water before the start of the tests. Median lethal concentrations were calculated for all toxicity tests with the trimmed Spearman–Karber method [16]. We measured total ammonia with an ion specific electrode using U.S. EPA Method 350.3 [17], with a lower detection level of 0.1 mg/L and an accuracy of ±20% over the concentration ranges reported.

Summary of ammonia toxicity to freshwater mussels

The toxicity of ammonia varies with temperature and pH (which influence the fraction of total ammonia that exists in the ionized and more toxic un-ionized states). Recommended water quality criteria for ammonia have been presented as un-ionized ammonia (NH_3) [18] and as total ammonia as nitrogen ($NH_3 + NH_4^+ - N$) [14]. We used the original studies' reported total ammonia LC50s, if available. All reported un-ionized ammonia LC50s were converted to total ammonia as nitrogen using the reported temperature and pH data and a published p*K* relationship [19]; these were also normalized to pH 8 using the equations in appendix 3 of the U.S. EPA revised ammonia criteria document [14]. Concentrations for acute exposures are correspondingly reported as mg/L total ammonia as N at pH 8.

Acute toxicity data were summarized by the methodology described in U.S. EPA numeric water quality criteria guidelines [15]. In the process, available toxicity data are critically reviewed, and geometric mean LC50s for each genus (genus mean acute values [GMAVs]) are calculated. We calculated GMAVs in two ways: combined data for all mussel life stages within the genus (results from toxicity tests with glochidia, juvenile, and adult combined) and combined adult and juvenile data only (excluding the toxicity tests that used glochidia, the appropriateness of which has been questioned in toxicity tests to support water quality criteria development). The GMAVs are used in the demonstration of the sensitivity of mussels to ammonia relative to other invertebrates and fishes in the acute database of the current U.S. EPA ammonia criteria [14].

National water quality criteria in the United States generally consist of two estimated values designed to protect aquatic organisms; these are commonly referred to as the acute and chronic water quality criteria, but, more specifically, they are the criteria maximum concentration (CMC) and criteria continuous concentration (CCC), respectively. The CMC is an estimate of the highest 1-h average concentration that should not result in unacceptable adverse effects to aquatic organisms; the number is derived from acute toxicity tests (generally 48–96-h exposures) that use lethality or immobilization as the measured endpoints. In deriving the CMC, the GMAVs are ranked from highest (most tolerant) to lowest (most sensitive). A cumulative probability is assigned on the basis of those ranks, and a final acute value (FAV) is derived as the fifth percentile of the GMAVs using an equation that gives equal weight to the GMAVs of the four genera with percentile ranks closest to 0.05. The CMC is calculated by dividing the FAV by two and results in a concentration that should not severely adversely affect too many individuals within the taxa (taxon) that were used for deriving the FAV [15]. Evaluation of acute toxicity data has generally shown that dividing an LC50 or median effective concentration by two provides a concentration equal to a very low effect or no-effect concentration. The process, by definition, is designed to protect populations of 95% of the species tested from adverse effects of short-term exposures to nonbioaccumulative chemicals.

We added the unionid GMAVs to the acute data set for ammonia toxicity in the current U.S. EPA criteria document [14] and used equations from the U.S. EPA water quality criteria methodology [15] to derive acute exposure water quality guidance for protection of freshwater mussels (a recalculation of the FAV and CMC following inclusion of the freshwater mussel GMAVs). We defined outputs from this process as a freshwater mussel FAV (FAV_{FM}) and a freshwater mussel criteria maximum concentration (CMC_{FM}). Each of these values was derived in two ways: recalculation with addition of freshwater mussel GMAVs from tests with all mussel life stages and recalculation with addition of GMAVs from tests with adult and juvenile mussels only. Our use of the U.S. EPA water quality criteria equations to derive the CMC_{FM} is not intended to imply the outcome of a recalculated U.S. EPA acute ammonia criteria (which would likely include adding other data generated since the 1985 criteria document); it is intended to suggest general guidance for protection of freshwater mussels from short-term ammonia exposure.

No chronic ammonia exposure data existed for freshwater mussels. Therefore, no ammonia acute:chronic ratios (ACR) for freshwater mussels can be calculated. Without these data, a definitive estimate of the continuous ammonia concentration that would not be harmful to mussels could not be calculated. To evaluate the protectiveness of the current U.S. EPA CCC, we estimated the upper and lower bounds of ACRs (defined here as estimated ACRs, or eACRs) that could be applied to our two FAV_{FM}s. The current U.S. EPA ammonia criteria document [14] reports seven genus mean ACRs for fish and aquatic invertebrates ranging from 1.9 to 10.9, and the maximum value from that range defined our upper-bound eACR. Our lower-bound eACR was derived by evaluating two subchronic freshwater mussel ammonia tests. In juvenile *Lasmigona subviridis* exposures, a geometric mean 4-d LC50 of 3.83 mg/L total ammonia as N at pH 8 and a 15-d LC50 of 0.57 mg/L total ammonia as N at pH 8 have been reported [20]; the ratio of these two LC50s is 6.7. In juvenile *Utterbackia imbecillis* studies [21], a 4-d LC50 of 10 mg/L total ammonia as N at pH 8 and a 9-d no-observed-effect concentration of 2.6 mg/L total ammonia as N at pH 8 can be estimated; the ratio of these concentrations is 3.8. The geometric mean of these two acute to subchronic ratios (5.0) defined our lower-bound eACR.

The two FAV_{FM}s were each divided by the two eACRs to yield an estimated range of criteria continuous ammonia concentrations that may be protective of freshwater mussels (defined here as a CCC_{FM}). These are then compared to the U.S. EPA ammonia CCCs. The estimated CCC_{FM}s are intended to frame a range of continuous ammonia concentrations that may be protective of freshwater mussels; however, these values are not intended to imply the outcome of a recalculated national CCC because the U.S. EPA did not use ACRs, relying instead on toxicity data from chronic tests.

RESULTS

Thirty LC50s for unionid acute (24–96-h) ammonia exposures were identified that included 10 species in eight genera (Table 1). Additional relevant ammonia toxicity data were retrieved by our search for the genera *Amblema*, *Utterbackia*, *Cyrtonaias*, and *Toxolasma* [12,21], but acute (≤96-h) LC50s were not reported in these studies, and they were not used in our acute data calculations. Two longer-term (9–15-d) LC50s were also identified (Table 1); these also were not used in our acute data calculations but are included for reference and the calculation of our lower-bound eACR. No chronic ammonia exposure data existed for unionids, and no assessments that incorporated sublethal endpoints were identified by our search.

Sensitivity of freshwater mussels to ammonia

Genus mean acute values for freshwater mussels ranged from 2.56 to 8.97 mg/L total ammonia as N, normalized to pH 8 (Table 2). These values are uniformly at the sensitive end of the range of GMAVs when added to the database used to calculate the U.S. EPA water quality criteria for ammonia [14]. Generally, glochidia were about two to four times more sensitive than juveniles in the three species for which acute data were available for both life stages (Table 1). Excluding tests with glochidia from the GMAV calculations changed their ranks but did not appreciably change the overall apparent ammonia sensitivity of mussels relative to other taxa represented in the database (Table 2).

Derivation of water quality guidance for freshwater mussels

Addition of unionid GMAVs to the acute data set for ammonia toxicity in the current U.S. EPA criteria [14] and use of equations from the U.S. EPA water quality criteria methodology [15] allowed us to recalculate water quality guidance with a data set in which mussels are well represented. Adding data from toxicity tests with all freshwater mussel life stages, the FAV_{FM} (3.50 mg/L total ammonia as N at pH 8) and corresponding CMC_{FM} (1.75 mg/L total ammonia as N at pH 8) were about 70% less than the FAV (11.23 mg/L total ammonia as N at pH 8 for use when salmonids are present) and CMC (5.62 mg/L total ammonia as N at pH 8 for use when salmonids are present) used in the calculation of the current acute water quality criteria (Table 3). The FAV_{FM} and CMC_{FM} using data from assays with only juvenile and adult freshwater mussels were about 60% less than the FAV and CMC (for use when salmonids are present) from the criteria document (Table 3). The CMC_{FM}s are even further below (about 75% on average) the CMC for application when salmonids are absent (8.40 mg/L total ammonia as N at pH 8).

The lower- and upper-bound eACRs (5.0 and 10.9, respectively) yielded estimates of CCC_{FM}s from 0.3 to 0.7 mg/L total ammonia as N at pH 8 and 25°C when applied to our FAV_{FM} calculated with toxicity data for all mussel life stages. The range increased slightly (0.5–1.0 mg/L total ammonia as N at pH 8 and 25°C) when applied to our FAV_{FM} calculated following addition of toxicity data from tests with only juvenile and adult mussels. The range of CCC_{FM}s are between 20 and 75% less than the U.S. EPA CCC of 1.24 mg/L total ammonia as N at pH 8 and 25°C.

DISCUSSION

Freshwater mussel data are not included in the current database for calculation of the U.S. EPA water quality criteria for ammonia. Recently available data for this family includes eight GMAVs that are less than the GMAVs used to derive the CMC in the U.S. EPA ammonia criteria document, 14 acute LC50s that are less than the CMC, and two LC50s that are less than the final CCC. These data indicate that freshwater mussels are sensitive to ammonia relative to other invertebrates and fishes and that the current numeric criteria may not be protective of mussels, many of whose nearly 300 species are in widespread decline in North America.

Issues related to the 1999 revision to the ammonia criteria

The scope of the 1999 revision to the U.S. EPA water quality criteria for ammonia did not include a comprehensive literature search and review of the most recent acute toxicological data [14], relying instead on the database from the 1985 criteria [18]. The 1985 database was relatively large with 34 genera represented, and this number significantly exceeded the minimum database requirements for derivation of numeric criteria [15]. Also, that revision was initiated in 1996, when much of the data reviewed here [20,22–24] were not available. Our analyses indicate that mussels would rank at the sensitive end of the distribution of GMAVs used to calculate the CMC. The additional data for mussels could drive the derivation of acute criteria, indicating that unionids may be underprotected by the existing CMC. A recent review of methods for deriving numeric water quality criteria notes the importance of determining whether one particular type of organism is more sensitive to a particular pollutant than other kinds of animals [25]. This information helps guide minimum database requirements. While incorporation of additional data requires expenditure of limited resources, our assessment indicates that freshwater mussels should be represented in the criteria database for ammonia. Also, the apparent ammonia sensitivity of genera within this widely distributed family may merit acute criteria revision for reasons of ecological integrity.

Prior to dividing by two to generate the CMC, the FAV can be lowered if the species mean acute value for a recreationally or commercially important species is less (more sensitive) than the calculated FAV [15]. This approach was used in the U.S. EPA ammonia criteria [14] to lower the FAV to the species mean acute value for rainbow trout (*Oncorhynchus mykiss*) prior to deriving the CMC. The applicability of this provision for freshwater mussel protection has not, to our knowledge, been evaluated. Some species of freshwater mussels have commercial importance in the cultured pearl and jewelry industries [5], and this could provide justification for lowering the FAV to a mussel species mean acute value for criteria development. That procedure could result in even lower estimates of acute criteria than the approach we used.

Our use of the U.S. EPA water quality criteria equations [15] to derive the CMC_{FM} is not intended to imply the outcome of a recalculated U.S. EPA acute ammonia criteria. Modifi-

Table 1. Toxicity data for ammonia and freshwater mussels. Median lethal concentrations (LC50s) reported in original references have been converted to mg/L total ammonia as N, normalized to pH 8

Species Life stage	Duration	Temp.	pH	LC50	Reference
Rainbow					
(*Villosa iris*)					
Glochidia	24 h	22	8.1	5.17	[9]
Glochidia	24 h	20	7.9	2.42	[22]
Juvenile	96 h	25	8.2	9.09	[22]
Juvenile	96 h	25	8.2	8.21	[22]
Juvenile	96 h	25	8.1	5.64	[22]
Juvenile	96 h	12	7.3	6.60	[24]
Juvenile	96 h	21	7.4	4.23	[24]
Paper pondshell					
(*Utterbackia imbecillis*)					
Glochidia	48 h	25	8.0	10.42	[20]
Glochidia	48 h	25	8.0	2.38	[20]
Glochidia	48 h	25	8.0	3.15	[20]
Glochidia	48 h	25	8.1	7.46	Manuscript in preparation[a]
Juvenile	96 h	25	8.0	2.73	[20]
Juvenile	96 h	25	8.3	15.46	[20]
Juvenile	96 h	25	8.2	8.00	[20]
Juvenile	96 h	25	8.2	7.13	[20]
Juvenile	96 h	25	8	19.67	Manuscript in preparation[a]
Giant floater					
(*Pyganodon grandis*)					
Adult	96 h	25	7.5	8.69	[22]
Adult	96 h	25	7.7	9.26	[22]
Green floater					
(*Lasmigona subviridis*)					
Juvenile	96 h	24	7.7	4.05	[20]
Juvenile	96 h	24	7.7	4.05	[20]
Juvenile	96 h	25	7.9	3.42	[20]
Atlantic pigtoe					
(*Fusconaia masoni*)					
Glochidia	24 h	25	7.6	2.56	[20]
Pheasantshell					
(*Actinonaias pectorosa*)					
Glochidia	48 h	25	8	3.76	Manuscript in preparation[a]
Juvenile	96 h	25	8	14.05	Manuscript in preparation[a]
Cumberland moccasinshell					
(*Medionidus conradicus*)					
Glochidia	48 h	25	8	4.24	Manuscript in preparation[a]
Fatmucket					
(*Lampsilis siliquoidea*)					
Juvenile	96 h	24	8.3	0.74	[23]
Juvenile	96 h	24	8.3	2.27	[23]
Plain pocketbook					
(*Lampsilis cardium*)					
Juvenile	96 h	20	8.5	9.97	Personal communication[b]
Wavy-rayed lampmussel					
(*Lampsilis fasciola*)					
Juvenile	96 h	12	7.8	10.88	[24]
Juvenile	96 h	21	8.0	7.18	[24]
Longer-term tests					
Utterbackia imbecillis					
Juvenile	9 d	24	7.8	3.05	[21]
Lasmigona subviridis					
Juvenile	15 d	22	8.0	0.57	[20]

[a] A. Keller, U.S. Environmental Protection Agency (Jacksonville, FL).
[b] T.J. Newton, (U.S. Geological Survey, Upper Midwest Environmental Sciences Center, LaCrosse, WI, personal communication) (water-only exposure).

cation to the national criteria would likely not be done by adding data solely from a particular family but would rely on all data generated since the 1985 criteria document. In addition, the U.S. EPA may apply additional data quality objectives in evaluating the suitability of data for inclusion in their database. Finally, the addition of eight new genera all in one family and largely occurring in the eastern United States would need to be evaluated for how this might inappropriately skew a database used to derive a national criteria.

Freshwater mussel toxicity data and guidance

The absence of standard toxicity testing methods for this taxa helps explain the lack of robust toxicity data and the hesitancy on the part of the U.S. EPA and others to utilize

Table 2. Comparison of freshwater mussel genus mean acute values (GMAVs) for ammonia toxicity to other sensitive taxa from the U.S. Environmental Protection Agency database, listed in order of increasing sensitivity. All GMAVs are in mg/L total ammonia as N, normalized to pH 8

Genus rank	All mussel life stages[a]		Juvenile and adult mussel life stages[b]	
	Genus	GMAV	Genus	GMAV
12	*Oncorhynchus*	21.95	*Salmo*	23.74
11	*Etheostoma*	17.96	*Lepomis*	23.61
10	*Notemigonus*	14.67	*Oncorhynchus*	21.95
9	*Prosopium*	12.11	*Etheostoma*	17.96
8	*Pyganodon*[c]	8.97	*Notemigonus*	14.67
7	*Actinonaias*[c]	7.27	*Actinonaias*[c]	14.05
6	*Utterbackia*[c]	6.71	*Prosopium*	12.11
5	*Villosa*[c]	5.47	*Pyganodon*[c]	8.97
4	*Medionidus*[c]	4.24	*Utterbackia*[c]	8.61
3	*Lampsilis*[c]	4.20	*Villosa*[c]	6.52
2	*Lasmigona*[c]	3.83	*Lampsilis*[c]	4.20
1	*Fusconaia*[c]	2.56	*Lasmigona*[c]	3.83

[a] Freshwater mussel GMAVs presented using data from toxicity tests with adult, juvenile, and glochidial mussels.
[b] Freshwater mussel GMAVs excluding data for toxicity tests with glochidia. Note that no data are available for juvenile or adult life stages of *Medionidus* or *Fusconaia*.
[c] Freshwater mussel genera.

unionid ammonia toxicity data that have been available for nearly a decade [9,21] and more recently [20,22–24]. A need exists to work toward standardizing the toxicity tests for early life stages of freshwater mussels. Challenges to using these organisms include difficulty in their laboratory culture, uncertainty over appropriate test durations relative to their long life span, lack of sensitive sublethal endpoints, and the potential importance of including sediment in laboratory exposures aimed at reproducing environmental conditions [9,26]. While a need exists for standard methods, our results indicate good agreement among the results for 10 species, which addressed three mussel life stages and were generated by eight independent investigators. These data should be useful in establishment of ammonia criteria or state or local water quality standards.

The 10 species for which acute ammonia exposure data are available represent only about 3% of the unionid species known from North America, and the eight genera represent about 20% of the genera within this family [1]. Additional acute toxicity data would be beneficial for these species, although sufficient data seem to exist to support revision of the U.S. EPA acute ammonia criteria or establishment of state or local water quality standards for acute exposure. In the interim, our CMC_{FM}s may be used as approximations of the water quality conditions that protect mussels from acute ammonia exposures.

Chronic exposure data and sublethal endpoints assessments are generally lacking for mussels and should be initiated. Our process for deriving the CCC_{FM}s was not equivalent to the process used by U.S. EPA to derive the current ammonia CCC. The U.S. EPA did not use ACRs in deriving the CCC but rather relied directly on toxicity data from chronic tests. Adding another group with acute but no chronic data would not necessarily change the CCC under that procedure. Also, the lack of ACRs for mussels and ammonia is a hindrance. Our eACRs would likely not be used in a national criteria recalculation that would favor use of actual chronic data or at least an ACR derived specifically from a long-term test evaluating sublethal impacts to mussels from ammonia. Our lower-bound eACR of 5.0, derived from 9- to 15-d ammonia toxicity tests with mussels that measured lethality as the test endpoints, is only an initial approximation of a suitable ACR. Our upper-bound eACR of 10.9 is also uncertain; it is merely the highest of the seven genus mean ACRs reported in the current U.S. EPA ammonia criteria document [14], but individual species ACRs for fish and aquatic invertebrates ranged from 1.2 to 20.7 [14]. Until long-term ammonia exposure and sublethal effects data are produced for mussels, it will be difficult to

Table 3. Comparison of ammonia final acute values (FAV) and criteria maximum concentrations derived from the U.S. Environmental Protection Agency (U.S. EPA) database used to calculate the current ammonia criteria to values recalculated with data sets expanded by adding freshwater mussel toxicity test results. All data are in mg/L, total ammonia as N, normalized to pH 8

Data set	Most sensitive genera	Calculated FAV[a]	Revised FAV[b]	CMC[c]
1999 revisions[d]	*Oncorhynchus* *Etheostoma* *Notemigonus* *Prosopium*	14.32	11.23[e]	5.62[f] 8.40[g]
Recalculation adding data for all mussel life stages	*Medionidus* *Lampsilis* *Lasmigona* *Fusconaia*	3.50	3.50	1.75
Recalculation adding data for adult and juvenile mussels only	*Utterbackia* *Villosa* *Lampsilis* *Lasmigona*	5.00	5.00	2.50

[a] Final acute value from equation on page 31 of Stephan et al. [15].
[b] Final acute value can be lowered to the species mean acute value for sensitive recreationally or commercially important species not protected by the calculated FAV.
[c] Criteria maximum concentration (one-half of FAV).
[d] All data from U.S. EPA [14].
[e] FAV lowered to the species mean acute value for rainbow trout.
[f] CMC when salmonids are present.
[g] CMC when salmonids are absent.

generate definitive protective state- or site-specific standards or national criteria for chronic exposure. In the interim, use of the CCC_{FM}s may be appropriate. The range we estimate by using data from all mussel life stages (0.3–0.7 mg/L total ammonia as N at pH 8) is similar to estimated safe ammonia concentrations for two unionid species [24] that are about 0.2 and 0.5 mg/L total ammonia as N when normalized to pH 8.

Because of ammonia's pH- and temperature-dependent ionization, the CMC varies with pH, and the CCC varies with pH and temperature. The criteria also vary, depending on the presence of salmonids (CMC) and fish early life stages (CCC), the sensitivity of which results in lower allowable ammonia concentrations. Our results suggest a need for criteria revision, but at least the more restrictive criteria (salmonids and sensitive life stages present) should apply until criteria are revised or state standards are adopted that incorporate the data reviewed here. Our CMC_{FM}s and CCC_{FM}s were calculated by normalizing all data to pH 8, and the CCC_{FM} used data at about 25°C; the equations in the U.S. EPA criteria document [14] will need to be applied to adjust these values for other pH and temperature combinations. Also, it is emphasized that our CMC_{FM} and CCC_{FM} define the magnitude of concentrations that may protect freshwater mussels provided that exposure duration and frequency components of the CMC and CCC are still applied [14,15].

Ammonia as a potential limiting factor in unionid survival and recovery

Ammonia may be a significant limiting factor for unionids given that concentrations above the guidelines that we derived have been documented. Moreover, sediment pore-water concentrations of ammonia typically exceed those of overlying surface water [13], thereby placing the infaunal freshwater mussels in the environmental compartment where ammonia concentrations are frequently elevated. Unionids' feeding strategies include filtration of surface and pore water, suspended sediment, and sediment-associated fine particles [27], also potentially increasing their ammonia exposure. Relative to reference sites, low freshwater mussel diversity and abundance have been observed downstream of significant ammonia sources [9,12], but definitive cause-and-effect relationships have not been documented in these or other field investigations of this issue [28]. More work is needed to establish the extent of linkage between the field exposure and effects data.

As a common pollutant to which unionids appear to be sensitive, ammonia should be considered among the factors that may be limiting survival and recovery of freshwater mussels. Moreover, our calculations did not consider additional margins of safety that could be recommended for protection of threatened or endangered mussel species in instances where information is specifically lacking. Because threatened or endangered mussels have not been tested for sensitivity to ammonia, additional approaches may be required.

Acknowledgement—Chris Ingersoll, Russ Erickson, and Sara Ward provided helpful reviews of an earlier version of the manuscript; their expertise is appreciated. Two anonymous reviewers provided comments that also improved the paper.

REFERENCES

1. Williams JD, Warren, ML Jr, Cummings KS, Harris JL, Neves RJ. 1993. Conservation status of freshwater mussels of the United States and Canada. *Fisheries* 18:6–22.
2. Neves RJ, Bogan AE, Williams JD, Ahlstedt SA, Hartfield PW. 1997. Status of aquatic mollusks in the southeastern United States: A downward spiral of diversity. In Benz GW, Collins DE, eds, *Aquatic Fauna in Peril: The Southeastern Perspective.* Special Publication 1. Southeast Aquatic Research Institute, Lenz Design and Communications, Decatur, GA, USA, pp 43–85.
3. Fuller SLH. 1974. Clams and mussels (Mollusca: Bivalvia). In Hart CW Jr, Fuller SLH, eds, *Pollution Ecology of Freshwater Invertebrates.* Academic, New York, NY, USA, pp 215–273.
4. Havlik ME, Marking LL. 1987. Effects of contaminants on Naiad mollusks (Unionidae): A review. Resource Publication 164. U.S. Fish and Wildlife Service, Washington, DC.
5. National Native Mussel Conservation Committee. 1998. National strategy for the conservation of native freshwater mussels. *J Shellfish Res* 17:1419–1428.
6. Richter BD, Braun DP, Mendelson MA, Master LL. 1997. Threats to imperiled freshwater fauna. *Conserv Biol* 11:1081–1093.
7. Keller AE. 1993. Acute toxicity of several pesticides, organic compounds, and a wastewater effluent to the freshwater mussel, *Anodonta imbecillis, Ceriodaphnia dubia,* and *Pimephales promelas. Bull Environ Contam Toxicol* 51:696–702.
8. Keller AE, Ruessler DS. 1997. The toxicity of malathion to unionid mussels: Relationship to expected environmental concentrations. *Environ Toxicol Chem* 16:1028–1033.
9. Goudreau SE, Neves RJ, Sheehan RJ. 1993. Effects of wastewater treatment plant effluents on freshwater mollusks in the upper Clinch River, Virginia, USA. *Hydrobiologia* 252:211–230.
10. Keller AE, Zam SG. 1991. The acute toxicity of selected metals to the freshwater mussel, *Anodonta imbecillis. Environ Toxicol Chem* 10:539–546.
11. Jacobson PJ, Farris JL, Cherry DS, Neves RJ. 1993. Juvenile freshwater mussel (Bivalvia: Unionidae) responses to acute toxicity testing with copper. *Environ Toxicol Chem* 12:879–833.
12. Horne FR, McIntosh S. 1979. Factors influencing distribution of mussels in the Blanco River of central Texas. *Nautilus* 94:119–133.
13. Frazier BE, Naimo TJ, Sandheinrich MB. 1996. Temporal and vertical distribution of total ammonia nitrogen and un-ionized ammonia nitrogen in sediment pore water from the upper Mississippi River. *Environ Toxicol Chem* 15:92–99.
14. U.S. Environmental Protection Agency. 1999. 1999 Update of ambient water quality criteria for ammonia. EPA 822-R-99-014. Office of Water, Washington, DC.
15. Stephan CE, Mount DI, Hansen DJ, Gentile JH, Chapman GA, Brungs WA. 1985. Guidelines for deriving numerical national water quality criteria for the protection of aquatic organisms and their uses. EPA 822/A85/100. U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC.
16. U.S. Environmental Protection Agency. 1993. Methods for estimating the acute toxicity of effluents and receiving waters to freshwater and marine organisms. EPA/600/4-90/027F. Office of Research and Development, Washington, DC.
17. U.S. Environmental Protection Agency. 1983. Methods for chemical analysis of water and wastes. EPA-600/4-79-020. Environmental Monitoring Systems Laboratory, Cincinnati, OH.
18. U.S. Environmental Protection Agency. 1985. Ambient water quality criteria for ammonia. EPA 440/5-85-001. Office of Water Regulations and Standards, Criteria and Standards Division, Washington, DC.
19. Emerson K, Russo RC, Lund RE, Thurston RV. 1975. Aqueous ammonia equilibrium calculations: Effect of pH and temperature. *J Fish Res Board Can* 32:2379–2383.
20. Black MC. 2001. Water quality standards for North Carolina's endangered mussels. Final Report. Department of Health Science, University of Georgia, Athens, GA, USA.
21. Wade DC. 1992. Definitive evaluation of Wheeler Reservoir sediment toxicity using juvenile freshwater mussels (*Anodonta imbecillis* Say). TVA/WR-92/25. Tennessee Valley Authority, Water Resources Division, Muscle Shoals, AL, USA.
22. Scheller JL. 1997. The effect of dieoffs of Asian clams (*Corbicula fluminea*) on native freshwater mussels (Unionidae). Masters thesis. Virginia Polytechnic Institute and State University, Blacksburg, VA, USA.
23. Myers-Kinzie M. 1998. Factors affecting survival and recruitment of Unionid mussels in small midwestern streams. PhD thesis. Purdue University, West Lafayette, IN, USA.
24. Mummert AK, Neves RJ, Newcomb TJ, Cherry DS. 2003. Sen-

sitivity of juvenile freshwater mussels (*Lampsilis fasciola*, *Villosa iris*) to total and un-ionized ammonia. *Environ Toxicol Chem* 22: 2545–2553.

25. Stephan CE. 2002. Use of species sensitivity distributions in the derivation of water quality criteria for aquatic life by the U.S. Environmental Protection Agency. In Posthuma L, Suter GW, Traas TP, eds, *Species Sensitivity Distributions in Ecotoxicology*. Lewis, Boca Raton, FL, USA, pp 211–220.
26. Newton TJ, Allran JW, O'Donnell JA, Bartsch MR, Richardson WB. 2003. Effects of ammonia on juvenile unionid mussels (*Lampsilis cardium*) in laboratory sediment toxicity tests. *Environ Toxicol Chem* 22:2554–2560.
27. Yeager MM, Cherry DS, Neves RJ. 1994. Feeding and burrowing behaviors of juvenile rainbow mussels, *Villosa iris* (Bivalvia: Unionidae). *J North Am Benthol Soc* 13:217–222.
28. Bartsch MR, Newton TJ, Allran JW, O'Donnell JA, Richardson WB. 2003. Effects of pore-water ammonia on in situ survival and growth of juvenile mussels (*Lampsilis cardium*) in the St. Croix riverway, Wisconsin, USA. *Environ Toxicol Chem* 22:2561–2568.

A-260

Subject: Comments for Triennial Review
From: "Marilyn Grolitzer" <mgrolitzer@nc.rr.com>
Date: Fri, 1 Sep 2006 10:36:11 -0400
To: "Connie Brower" <connie.brower@ncmail.net>
CC: "Jessica Scott" <JSScott@nc.rr.com>, "Ron Gregory" <rongregory@nc.rr.com>, "Dean Naujoks" <dean.nrf@worldnet.att.net>

Dear Ms. Brower,

As a concerned citizen and resident of Wake County I am submitting the following comments for the 2004-2006 NC Triennial Review of Water Quality Standards.

CLASS C WATERS

In support of the comments submitted by Clean Water for North Carolina, all classifications should include standards protective of both aquatic habitat and swimming and no classification of waters should be less than fully protective of human health. Although streams and creeks may not be designated for swimming, the reality is that neighborhood children and pets may play in these waters on a daily basis during the recreational seasons.

PROPOSED PARAMETERS

The parameters proposed by CWFNC of color, conductivity and radioactivity should be adopted. Regarding color, a shorter wavelength than 465nm should be adopted to detect aromatic compounds as this is indicative of potential toxicity concerns vs. aesthetic concerns.

WATER QUALITY CRITERIA/MANGANESE

Recent studies on the health effects of manganese have raised concerns as to the toxicity of manganese (see references listed below and attached message from a local medical expert). Medical literature has documented that manganese is toxic to the central nervous system and can cause learning and coordination disabilities, behavioral changes and a condition that is similar to Parkinson's disease. The Environmental Protection Agency (EPA) has set 0.05 milligrams/liter as the upper limit of manganese advisable in water supplies and also as the Current National Recommended Water Quality Criteria for human consumption. The limit, however, is based on odor and taste of the water. The potential risk of manganese accumulating in the brain through swimming, showering and drinking has not been considered by the EPA in setting this limit. In recent studies conducted at Wake Forest University Medical School the analysis by Spangler and Elsner found that concentrations well below 0.05 milligrams might lead to brain injury.

Recent testing by Wake County Soil and Conservation of water, soil and sediment near the EM Johnson Water Treatment Plant in North Raleigh has demonstrated extremely high manganese levels. Sediment in the neighboring creek, which is currently designated as WS-IV, contains manganese levels 47 times what a plant would normally uptake and 95 times the recommended level. Red clay soils throughout North Carolina contain manganese levels which are higher than the national average. The manganese levels in local soils are being further impacted by the widespread use of potassium permanganate as a water treatment chemical. Millions of pounds of manganese by-products are being discharged into streams and waterways throughout North Carolina and high manganese containing sludge is being routinely applied to fields throughout the region.

Increased amounts of manganese are now being found in ground water supplies. For example, a local well has been shown to have increased from 0.072mg/l to over 0.8mg/l of manganese within the last 15 months.

A-261

The cause of this increase in manganese in groundwater and surface waters has not yet been determined but may be due to over development in the region or local discharges from the water treatment plant or similar facilities. The bottom line is that the population within the region is being exposed to increasing levels of manganese in surface waters and ground waters and that these levels may be potentially damaging to human health.

The state should adopt a stricter limit on manganese than the current 200ug/l listed in the Redbook and increase monitoring and adherence to this limit. The limit should be brought into line with EPA national recommended water quality criteria for human consumption of 50ug/l.

Marilyn A. Grolitzer Ph.D.

Reference articles regarding manganese toxicity;

http://www1.wfubmc.edu/news/NewsArticle.htm?Articleid=1633

http://www.sixwise.com/newsletters/05/11/30/the_most_dangerous_toxin_that_almost_no_one_knows_about.htm

http://www.medicalnewstoday.com/medicalnews.php?newsid=26861

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=15913899&dopt=Abstract

http://www.waterquality.crc.org.au/hsarch/hs40e.htm

http://www.aquamd.com/resources/water_health/The%20Danger%20Lurking%20In%20Your%20Shower.htm

http://www.dhs.ca.gov/ps/ddwem/chemicals/manganese/notificationlevel.htm

http://www.atsdr.cdc.gov/toxprofiles/tp151.pdf

http://www.atsdr.cdc.gov/toxprofiles/phs151.html#bookmark03

http://www.inchem.org/documents/cicads/cicads/cicad12.htm

-----Original Message-----
From: Jessica S. Scott, MD [mailto:JSScottMD@nc.rr.com]
Sent: Friday, September 01, 2006 10:22 AM
To: mgrolitzer@nc.rr.com
Subject: Manganese toxicity

Dear Marilyn,

I am responding to your question and concern about appropriate Manganese levels in our local and state drinking water and for water used for recreation (swimming and fishing). I am happy to put together a more detailed report in the future, however, due to the time constraint of your needing my response in less than 24 hours, I will give you information to use highlighting some key points regarding Manganese effects on humans which underscores how essential it is to set appropriate level limits and then enforce that these levels are maintained. **A-262**

Increasingly, medical literature is documenting the toxic effects of Manganese and I quote from the Archives of Neurology from 2000, "Manganese plays an important role as a cofactor in many enzymatic reactions in humans but in excess amounts can cause irreversible nervous system damage." The author continues, "Manganese is a well-known cause of dystonic parkinsonism," and the devastating effects of this irreversible and severely disabling condition are well documented in the literature. Manganese primarily enters the body via inhalation and can cause significant respiratory symptoms, as well. We have seen learning difficulties in children due to the central nervous systems toxicity where elevated levels of Manganese have been documented in drinking water. Studies have demonstrated that children who consumed above "average" levels of drinking water did worse on cognitive testing. Finley stated in his article in April of 2004 that chronic low-levels of manganese in the environment can not only lead to learning disabilities in children but an increased propensity for violence in adults.

The dots are being connected now, like they have in the past with lead, for instance, and it is clear that Manganese levels need to be kept to a maximum level in our drinking water of 0.04mg/l or lower, which is more of the international standard, whereas current requirements in North Carolina, and elsewhere in the United States, are for levels up to 0.05mg/l. Additionally, our recreational water levels need to be reduced from the current NC standard of 0.2mg/l for reduced toxicity, as this level was set for color/odor properties rather than for the toxic health effects. Many researchers point out that safety data may need to be lower than results some studies would indicate due to assumptions such as the effects based on subjects who are "average 70kg man" versus lighter weight woman or even infant/child. Also, some medical conditions, which may be fairly common, may predispose certain individuals to increased toxicity at lower levels of exposure.

Finally, it is vital that more monitoring and adherence to these levels is mandated for the safety of the citizens of North Carolina.

Please let me know if I can be of further assistance to you.

Jessica S. Scott, M.D.

Subject: RE: Comments for Triennial Review
From: "Marilyn Grolitzer" <mgrolitzer@nc.rr.com>
Date: Fri, 1 Sep 2006 14:19:00 -0400
To: "Connie Brower" <connie.brower@ncmail.net>
CC: "Alan Clark" <alan.clark@ncmail.net>, <JSScott@nc.rr.com>, <rongregory@nc.rr.com>, <dean.nrf@worldnet.att.net>, <htaylor@gloryroad.net>, "Jeff Manning" <jeff.manning@ncmail.net>

Connie,

Thanks for confirming receipt of the submission of comments.

Regarding the links, as you may notice below in your message only part of the web page address on those pages has been highlighted.

Please ensure that the entire web address is copied;

http://www.sixwise.com/newsletters/05/11/30/the_most_dangerous_toxin_that_al
most_no_one_knows_about.htm

http://www.aquamd.com/resources/water_health/The%20Danger%20Lurking%20In%20Y
our%20Shower.htm

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_ui
ds=15913899&dopt=Abstract

If you still experience difficulties I will be happy to copy the text of the articles and e-mail them to you.

Marilyn Grolitzer

-----Original Message-----
From: Connie Brower [mailto:connie.brower@ncmail.net]
Sent: Friday, September 01, 2006 1:36 PM
To: Marilyn Grolitzer
Cc: Alan Clark; JSScott@nc.rr.com; rongregory@nc.rr.com; dean.nrf@worldnet.att.net; htaylor@gloryroad.net; Jeff Manning
Subject: Re: Comments for Triennial Review

Marilyn (and friends)
we appreciate the submission of comments with respect to the Triennial Review --however,
the following links do not provide me with a viable page --

I am getting "page not found" for this one:

http://www.sixwise.com/newsletters/05/11/30/the_most_dangerous_toxin_that_al
most_no_one_knows_about.htm

no current search query for this one:

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_ui
ds=15913899&dopt=Abstract

Page not found for this one:

http://www.aquamd.com/resources/water_health/The%20Danger%20Lurking%20In%20Y
our%20Shower.htm

A-264

Please , try to resubmit these to me in some other manner for consideration..

thanks again -- connie

Marilyn Grolitzer wrote:

A-265

Subject: RE: Comments for Triennial Review
From: "Marilyn Grolitzer" <mgrolitzer@nc.rr.com>
Date: Fri, 1 Sep 2006 16:00:42 -0400
To: "Connie Brower" <connie.brower@ncmail.net>
CC: "Alan Clark" <alan.clark@ncmail.net>, <htaylor@gloryroad.net>, "Jeff Manning" <jeff.manning@ncmail.net>

Connie,

I have pasted the articles under the links below.

Marilyn Grolitzer

----

http://www.sixwise.com/newsletters/05/11/30/the_most_dangerous_toxin_that_almost_no_one_knows_about.htm

The Most Dangerous Toxin that Almost No One Knows About
by www.SixWise.com

Most everyone is exposed to small amounts of manganese, a naturally occurring substance in our air, soil, water and food, daily. If kept in check, the body is able to control manganese levels by expelling extra amounts, but if the intake becomes too great, it can become overwhelming and cause a variety of health problems, including permanent nervous system damage.

What makes manganese so dangerous is that the current safety levels may not be adequate, so people may be taking in dangerous levels of this compound that almost no one is aware of.

Is there a hidden danger in your shower?

Nearly 9 Million Americans Exposed to Dangerous Manganese Levels

According to a study by John Spangler, M.D., an associate professor of family medicine, and other researchers from Wake Forest University School of Medicine, "Nearly 9 million people in the United States are exposed to manganese levels that our study shows may cause toxic effects."

Exposure can occur via many routes, drinking water, foods, manganese-containing pesticides, air, and more, but the researchers found that the most concerning source may come from something most of us do daily: shower.

The study found that after showering 10 minutes a day for 10 years in manganese-contaminated water:

Children would be exposed to doses of manganese three times higher than doses that resulted in manganese deposits in the brains of rats.

Adults would be exposed to doses 50 percent higher than the rats.

Damage may Occur at Levels Considered Safe by the EPA

Perhaps most concerning is that permanent damage to the nervous system may occur after exposure to manganese levels that the Environmental Protection Agency (EPA) has noted as safe.

According to the EPA, 0.5 milligrams/liter is the upper limit of manganese in water supplies, based on odor and taste of the water. However, the amount of manganese accumulated by breathing in shower vapors has not been considered, and even at 0.5 milligrams/liter researchers say manganese could cause brain injury.

"Inhaling manganese, rather than eating or drinking it, is far more efficient at delivering manganese to the brain," Spangler said. "The nerve cells involved in smell are a direct pathway for toxins to enter the brain. Once inside these small nerves, manganese can travel throughout the brain."

Health Risks of Manganese

High levels of manganese are toxic to the nervous system and can cause:

Learning and coordination disabilities

Behavioral changes

Parkinson's-like disease

Permanent brain injury

Slow and clumsy body movements

According to Spangler, the elderly, pregnant women, children and people with liver disease are particularly susceptible to manganese toxicity, and may develop problems even at low doses in water supplies.

"If our results are confirmed, they could have profound implications for the nation and the world," Spangler said.

Major Sources of Manganese

People who work in, or live near, a factory that produces manganese metal are likely exposed to high levels of manganese dust in the air. Likewise, those living near a coal- or oil-burning factory are also exposed to high levels, as manganese is released into the air when fossil fuels are burned.

Manganese is also added to some gasoline, which could pose a threat to those living in urban areas, working in garages or spending a lot of time in bus stops.

Further, "The manganese, as it settles from car exhaust onto streets and highways, may enter the water supply, increasing manganese levels in the water we drink and bathe in," said Spangler.

Don't worry about naturally occurring manganese in food--toxicity from this source has never been documented.

Other potentially risky sources include:

Soy infant formula: Soybean plants may take in manganese from the soil and concentrate it. Soy formula may have 200 times the manganese level found in breast milk, which can lead to brain damage in infants and behavioral changes in adolescents, according to Dr. Francis Crinella, clinical professor of pediatrics at UC-Irvine, and Trinh Tran, a graduate researcher at the UC-Davis Department of Animal Studies.

Wells and private water supplies (may contain higher levels than public water supplies)

Reducing Your Risk of Manganese Toxicity

Manganese is a necessary nutrient that should be included in your diet. Limiting foods that contain manganese is therefore not a good idea, as toxicity from manganese in foods has not been documented. Rich food sources of manganese include whole grains, nuts, leafy vegetables and tea.

A-267

If you are concerned of your exposure to manganese via water supplies or air, however, it would be prudent to take precautions, including:

Have your drinking and bathing water tested for manganese levels

Invest in a water filter and shower filter that will remove manganese, if necessary

Try to avoid congested urban areas and other regions with a lot of exhaust fumes

Avoid living near or working in manganese metal or coal-burning factories if possible

----

--

http://www.aquamd.com/resources/water_health/The%20Danger%20Lurking%20In%20Your%20Shower.htm

The Danger Lurking in Your Shower

A new study from the Wake Forest University School of Medicine claims that you risk permanent nervous system (brain) damage if you regularly inhale water vapor when showering, which contains manganese.

What is Manganese?

Manganese is one of the most abundant metals in the earth and is used extensively in making steel, welding rods, paints, fireworks, fertilizers, varnish, livestock supplements and so forth. It's also added to gasoline to reduce engine knocking.

Manganese is likely found so extensively in water supplies because it is highly abundant in the earth and because of its use in gasoline.

Most everyone is exposed to small levels of manganese from the food they eat or mineral supplements they take. Low levels of manganese are essential for good health, but high levels of manganese are toxic.

What Researchers Found

The analysis was conducted by Dr. John Spangler, M.D. and Dr. Robert Elsner, Ph.D.
They analyzed the levels of manganese that caused central nervous system damage in rodents by accumulating inside their brains. They then reviewed medical literature and animal studies to determine how much manganese people would absorb by showering a mere 10 minutes a day.

They found that by taking brief, daily showers over the course of 10 years, children would be exposed to three times the level of manganese that the rodents were exposed to; adults would be exposed to 50 times more.

This also indicates that adults taking "brief showers" for only one year would still be exposed to five times more manganese than those rodents who suffered brain damage.

The doctors felt that even though all individuals could be at risk from manganese toxicity as a result of their water supply, children, pregnant women, the elderly and those being treated for liver disease are at the highest risk, even when exposed to low doses of manganese when showering.

Additional Facts

These doctors are very concerned about your exposure to manganese levels that the Environmental Protection Agency (EPA) currently says are safe for

A-268

drinking water. The EPA standard for "safe levels" of manganese in drinking water supplies is 0.5 milligrams per liter.

But that standard for manganese is a "secondary standard," which means the EPA only considers manganese to be a nuisance and not a health hazard. And because it is a secondary standard, it is completely unenforceable by the EPA.

So, if your water supply has high levels of manganese, the water company is free to say that it is completely safe--even when it could, in fact, be the exact opposite.
Worse, the EPA standard was based on anticipated exposure by ingesting drinking water. But this new study states that "drinking water" is not the hazard for exposure to manganese toxicity. Instead, the danger is absorbing manganese from water vapor inhalation when showering.

By the way, in the years since the EPA standard was set, and before this latest research, other studies have shown that inhaling manganese dust could result in nervous system damage, learning and coordination disabilities and behavioral changes that are very similar to Parkinson's disease. In fact, back in 1993 the National Institute of Health issued a statement that occupational exposure to manganese for periods of just six months to two years could result in a disease of the central nervous system that resembles Parkinson's disease.

Moreover, these researchers feel that inhaling manganese from water vapor bypasses the blood supply and travels directly to your brain. Once there, it can cause extensive nervous system damage.

How Much Manganese is in Your Water?

Whether you are on a public water system or a private well, you really should find out if manganese or other dangerous contaminants are in your water. If you are on a public water system (85 percent of people are), chances are good that you are exposed to some level of manganese, trihalomethanes, haloaecetic acids, chlorine and other harmful contaminants.

Once you determine the type and level of contaminants in your water supply, you can get the right water treatment system to purify it; and you can consult your health practitioner to help reverse any damage you may have suffered from exposure to those contaminants.

-

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=15913899&dopt=Abstract

Neurotoxicity of inhaled manganese: public health danger in the shower?

Elsner RJ, Spangler JG.

Wake Forest University School of Medicine, Department of Family and Community Medicine, Medical Center Blvd., Winston-Salem, NC 27157-1084, USA.

CONTEXT: Manganese (Mn) is an essential trace element but is neurotoxic at high doses. Showering with Mn-laden water has never been evaluated as a central nervous system (CNS) delivery vector for Mn, even though intranasally administered Mn in laboratory animals circumvents the blood-brain barrier and passes directly into the brain via olfactory pathways. OBJECTIVE: To review the literature on Mn and attempt to quantify potential human CNS exposure to manganese from showering. DATA SOURCES: We systematically searched Medline 11/9/02 and again on 3/9/04. The following search terms were used: manganese, water, drinking water, shower, showering,

bath, bathing and inhalation, then combined with "water or drinking water or showering or shower or bathing or inhalation." STUDY SELECTION: Animal experimental investigations, human epidemiological studies, and consensus and governmental reports were utilized. DATA EXTRACTION: Data were extracted by both authors and extrapolations to humans were calculated by one of us (JGS) controlling for age, length of exposure and known respiratory differences between rats and humans. DATA SYNTHESIS: During a decade of showering in Mn-contaminated water, models for children and adults show higher doses of aerosolized Mn (3-fold and 112-fold greater, respectively) than doses reported to cause Mn brain deposition in rats. CONCLUSIONS: Long-term shower exposure to Mn-laden water may pose a significant risk for CNS neurotoxicity via olfactory uptake in up to 8.7 million Americans. If our results are confirmed, regulatory agencies must rethink existing Mn drinking water standards. A-269

If you still experience difficulties I will be happy to copy the text of the articles and e-mail them to you.

Marilyn Grolitzer

BLUE RIDGE
PAPER PRODUCTS INC.

July 31, 2006

CERTIFIED MAIL
RETURN RECEIPT REQUESTED
7099 3220 0007 0371 2220

Connie Brower
DENR
Division of Water Quality Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

Subject: **2004-2006 Triennial Review of Surface Water Quality Standards**
Blue Ridge Paper Comments

Dear Ms. Brower:

Blue Ridge Paper (Blue Ridge) would like to request a copy of any comments made during the public hearings on the color variance.

Blue Ridge has submitted extensive information related to the color variance through the NPDES permit renewal process. Those submittals constitute the Company's comments on the color variance. If you have any questions, please call at the number below.

Sincerely,

J. Glenn Rogers
Water Compliance Coordinator
828-646-2874

cc: Roger Edwards
Surface Water Protection Supervisor
Division of Water Quality
North Carolina Department of Environment
and Natural Resources
Asheville Regional Office
2090 US Highway 70
Swannanoa, North Carolina 28778

Blue Ridge Paper Products - Environmental Group
175 Main Street • PO Box 4000
Canton, North Carolina 28716 • 828-646-2000

Raising Your Expectations

Internal Distribution:

cc: C-File Water
D. Brown
B. Williams
P. Dickens

Blue Ridge Paper Products Inc. - Environmental Group
175 Main Street • PO Box 4000
Canton, North Carolina 28716 • 828-646-2000

Progress Energy

August 28, 2006

Ms. Connie Brower
NCDNR/DWQ-Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

RE: Comments of Progress Energy Carolinas, Inc. on Rulemaking Proposal to Amend Portions of 15A NCAC 02B – Surface Water and Wetlands Standards

Dear Ms. Brower:

Progress Energy Carolinas, Inc. (PEC), a subsidiary of Progress Energy, provides electricity and related services to more than one million customers in North Carolina. The company is headquartered in Raleigh and serves a territory within North Carolina that encompasses more than 29,000 square miles including the cities of Raleigh, Wilmington, Fayetteville, and Asheville. PEC owns and operates 17 power plant sites in North Carolina (NC) with a total generating capacity of 11,000 megawatts electric. Many of these plants discharge wastewater in accordance with the terms and conditions set forth in individual, and in some cases, general National Pollutant Discharge Elimination System (NPDES) permits. NPDES permit limits are established for pollutants that have reasonable potential to cause or contribute to an excursion that exceeds a water quality standard. To the extent that the proposed modifications to the NC Surface Water and Wetlands Standards could result in modification of discharge limitations for one or more of its plants, PEC could be impacted by the subject rulemaking and accordingly, has reviewed the proposed changes closely. The following comments are being submitted by Progress Energy Service Company, LLC on behalf of PEC.

PEC believes that the existing and proposed NC water quality standards for beryllium are inappropriate and strongly recommends they be omitted. The existing water quality standards for beryllium in 15A NCAC 02B and the proposed amendments, appear to be based on EPA's "Water Quality Criteria for 1986," often referred to as the Gold Book [1]. Over the last 20 years, EPA's recommended water quality criteria for beryllium have been reassessed and updated. In 1999, EPA published "corrections" for its water quality criteria.[2] The 1999 publication does not recommend any water quality criteria for beryllium, but does contain two important footnotes specifically for beryllium. One footnote clearly states that "EPA has not calculated human health criterion for this

[1] Quality criteria for water 1986. Washington, DC: Office of Water Regulations and Standards, U.S. EPA. EPA 440/5-86-001.
[2] National recommended water quality criteria-correction. Washington, DC. U.S. Environmental Protection Agency, Office of Water 4304. EPA 822-Z-99-001. April, 1999.

Progress Energy Service Company, LLC
P.O. Box 1551
Raleigh, NC 27602

contaminant" while the other footnote points out that EPA has established a maximum contaminant level (MCL) for beryllium in its National Primary Drinking Water Regulations. In 2000, EPA promulgated numerical criteria for the 126 priority toxic pollutants to "fill a gap in California's water quality standards."[3] Again, EPA did not specify any criteria, neither for the protection of aquatic life or human health, for beryllium. In the 2000 rule, a footnote for beryllium states that "EPA has not published an aquatic life criterion value." In recent years, EPA has maintained a web site where its "Current National Recommended Water Quality Criteria" are compiled and listed in a summary table.[4] At their web site, EPA currently specifies no numeric criteria for beryllium for the protection of aquatic life or human health.

PEC believes it may be appropriate to establish a water quality standard for beryllium applicable to surface waters within water supply watersheds classified as WS-I, II, III, IV, or V. Moreover, PEC believes that the water quality standard should be consistent with the federal MCL for beryllium, which is 0.004 mg/L, as codified at 40 CFR Part 141.

PEC appreciates this opportunity to comment and looks forward to working with you in the future. If you have questions concerning the Company's comments, please contact me at (919) 546-3775 or Mick Greeson at (919) 546-5438.

Sincerely,

Victoria K. Will

Victoria K. Will
Director
Environmental Services

VKW:mrg

[3] Federal Register/Volume 65, Number 97/Thursday, May 18, 2000/pp. 31682-31719.
[4] U. S. Environmental Protection Agency, Current National Recommended Water Quality Criteria, http://www.epa.gov/waterscience/criteria/wqcriteria.html

A-274

Duke Energy®

Duke Energy Corporation
526 South Church St.
Charlotte, NC 28202

Mailing Address:
PO Box 1006
Charlotte, NC 28201-1006

August 31, 2006

Ms. Connie Brower
NCDNR/DWQ-Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

Subject: Comments of Duke Power Company LLC on Rulemaking Proposal to Amend Portions of 15A NCAC 02B – Surface Water and Wetlands Standards

Dear Ms. Brower:

Duke Power Company LLC (Duke Power), a subsidiary of Duke Energy, provides electricity and related services to more than two million customers in the Carolinas, as well as several mid-West states. The company is headquartered in Charlotte and serves a territory within North and South Carolina that encompasses more than 22,000 square miles. In the Carolinas, Duke Power's three nuclear plants, eight coal-fired stations and 27 hydroelectric stations and combustion turbine plants are among the most efficient in the nation. These stations account for approximately 18,000 megawatts of electric generation. Most of these plants discharge wastewater in accordance with the terms and conditions set forth in individual, and in some cases, general National Pollutant Discharge Elimination System (NPDES) permits. NPDES permit limits are established for pollutants that have reasonable potential to cause or contribute to an excursion that exceeds a water quality standard. To the extent that the proposed modifications could result in modification of permit limits for one or more of its plants, Duke Power could be impacted by the subject rulemaking and accordingly, has reviewed the proposed changes closely. The following comments are being submitted by Duke Power Company, LLC on behalf of Duke Energy Corporation.

Given that EPA recommends no national water quality criteria for beryllium, Duke Power believes that the current and proposed NC water quality standards for the substance are inappropriate and strongly recommends they be omitted. However, Duke Power believes it may be appropriate to establish a water quality standard for beryllium applicable to surface waters within water supply watersheds classified as WS-I, II, III, IV, or V. Moreover, Duke Power believes that the water quality standard should be consistent with the federal drinking water standard for beryllium, 0.004 mg/l, as codified at 40 CFR Part 141.

Duke Power requests that NC DENR utilize sound, region specific scientific guidance provided by the U.S. Environmental Protection Agency (EPA) for the calculation of Relative Source Concentration (RSC) values to account for non-water sources of exposure. In the event that EPA guidance is too generic and therefore inappropriate, Duke Power requests the ability to perform site specific scientific demonstrations to more accurately determine RSC values.

Duke Power recommends that for Class C Waters (15A NCAC 02B .0211) that the numerical water quality standard for cadmium should not be reduced from 2.0 µg/l (non-trout waters or 0.4 µg/l for trout waters) to 0.16 µg/l. Duke Power contends that this 0.16 µg/l value is based on an EPA metals translator and water hardness effect that is overly conservative. Additionally this proposed value is well below the present analytical detection limit for cadmium. Therefore Duke Power supports the retention of the current cadmium water quality standards.

Duke Power appreciates this opportunity to comment and looks forward to working with you in the future. If you have any questions or comments, please call me at (704) 382-4309

Sincerely,

Allen Stowe

Allen Stowe
Scientist, Water Management

A-276

Subject: 2006 Triennial Water Quality Standards Review
From: Ken.Vogt@wilmingtonnc.gov
Date: Thu, 24 Aug 2006 11:06:20 -0400
To: connie.brower@ncmail.net
CC: Hugh.Caldwell@wilmingtonnc.gov

Ms Brower,

I attended the 07/26/2006 public hearing in Wilmington, NC scheduled to collect input on the 2006 Triennial Water Quality Standards Review. I spoke briefly at this hearing, and I am also taking the opportunity of reinforcing the comments I provided at that time in this written response.

I noted that from my review of the primary issues being amended that I would be commmenting more so on what was not under consideration for amendment than what was under consideration for amendment.

The appropriateness of the 5.0 mg/l DO standard within the lower Cape Fear River estuary is apparently believed to be acceptable as currently codified insofar as it is apparently not a matter under consideration within this public hearing/review/amendment/rulemaking process.

I'm not sure the facts support the conclusion reached in that the consideration of current designated uses, corresponding water quality standards, extent of achievement of the applicable DO standard, and use attainability would yield a determination that the waterbody is impaired and is warranting of TMDL imposition in order to regain designated uses. Along these lines, I have not become convinced that designated uses could not be attained unless DOs exceed 5.0 mg/l and that a 5.0 mg/l DO standard was applicable or attainable given the significant swampwater effects influencing DO within the estuary.

A TMDL for low DOs within the estuary is currently underway. We've been advised throughout the TMDL process that the TMDL process was not the appropriate forum for making the preceding observations; I'm assuming the triennial review process is. I would suggest that reevaluation of the appropriateness of the current DO standard within the lower Cape Fear River estuary, its ability to assure designated uses by meeting or exceeding this critical threshold value (in other words, can the designated uses be met at lesser DOs?), and its ability to be attained on a basis consistent with DWQ-applied criteria due to significant swampwater effects (in other words, can the currently-applicable water quality standards and corresponding designated uses be attained at all?) all affect the subsequently applied impairment designation and imposition of the TMDL process, and may actually render the TMDL process unnecessary and suggest delisting.

I would appreciate the agency's favorable consideration of the merits of these observations and the subsequent addressment of them throught the appropriate regulatory process.

Sincerely,
Ken Vogt

Kenneth L. Vogt Jr., P.E., B.C.E.E.
Wastewater Treatment Superintendent
City of Wilmington
P.O. Box 1810
2311 North 23rd Street
Wilmington,NC 28402-1810
910.341.7890 (PH); 910.341.4659 (F); 910.470.8701 (M)
ken.vogt@wilmingtonnc.gov

A

RIEGELWOOD MILL
865 JOHN L. RIEGEL ROAD
RIEGELWOOD, NC 28456
PHONE 910-362-4900

August 30, 2006

Ms. Connie Brower
Planning Section
NC Division of Water Quality
1617 Mail Service Center
Raleigh, NC 27699-1617

Subject: Comments on Triennial Review of Water Quality Standards

Dear Ms. Brower:

International Paper has been a member of the Lower Cape Fear River Program since its inception over 10 years ago and been actively involved with water quality and water resources management issues in the Cape Fear River Basin. We have been actively involved in the TMDL stakeholder group and discussions related to development of a water quality model for the lower river/estuary. Because of this interest, we are providing comments on North Carolina's triennial review of water quality standards as required by the Clean Water Act. In particular, we are commenting on the water quality standard for dissolved oxygen (DO) in the lower Cape Fear River.

Although DO is not included in the list of water quality criteria that are being considered for modification by the Division of Water Quality (DWQ) as part of this triennial review, we believe it is important for the state to consider modifying the DO standard for SC waters. As outlined in our letter below, there is little scientific basis for North Carolina's current DO standard in SC waters, and EPA has developed revised criteria for DO for coastal waters in the Virginian Province.

Cape Fear River Background

A major portion of the Lower Cape Fear River/Estuary from Toomers Creek to Snows Cut is rated as impaired due to sampling data indicating DO and pH below standard. It is clear from the *Cape Fear River Basinwide Water Quality Plan*, that distinctions between the Class C Sw and Class SC waters are critical to the impairment determination. The impaired areas are primarily in the Class SC sections of the river. The Class C standard for DO is a daily average of 5 mg/L with an instantaneous minimum of 4 mg/L. Therefore, instantaneous

Ms. Connie Brower
Page 3
August 30, 2006

02B .0212(a)(3)(B) --- *Dissolved oxygen: not less than 5.0 mg/l, except that swamp waters, poorly flushed tidally influenced streams or embayments, or estuarine bottom waters may have lower values if caused by natural conditions;*

Alternative DO Criteria

There is good technical support for a revision to the tidal saltwater DO criterion. EPA in 2000 published a DO criterion for saltwaters in the Virginian Province (Cape Cod to Cape Hatteras) that is applicable to estuarine and ocean waters. This table establishes an instantaneous minimum of 2.3 mg/L based on juvenile and adult aquatic life survival and a continuous concentration of 4.8 mg/L. While the Cape Fear River estuary is a little south of this area, EPA has used the criterion for interpretation of the narrative DO standard for the Savannah River. The criteria table (Attachment 2) from the criteria document summarizes the criterion.

In summary, International Paper encourages DWQ to review its water quality criterion for DO in SC waters. At a minimum, DWQ should require a use attainability analysis for any TMDL being developed for DO in SC waters since the current critierion will have a critical impact on the final TMDLs and their allocation. Data compiled by EPA indicate that North Carolina's DO criterion for salt water may be high. EPA indicates in their TMDL guidance (http://www.epa.gov/owow/tmdl/decisions/dec2.html) that the applicability of water quality standards should be reviewed in conjunction with development of a TMDL.

International Paper certainly acknowledges the effort that DWQ puts into development of its water quality standards, TMDLs, and other documents and appreciates the opportunity to comment. If you have any questions or would like to discuss these matters, please contact me at (910) 655-6229 or by email at Edward.Kreul1@ipaper.com.

Sincerely,

Edward J. Kreul
Manager - Environmental Performance

Attachment 1

Original Class C and SC DO Criteria

North Carolina's Surface Water Standard History for Dissolved Oxygen

Class SC

11/18/1953 *__SECTION IV: (CLASS SC) (3)__ Dissolved Oxygen: Not less than 4.0 parts per million, except the swamp waters may have a minimum of 3.0 parts per million.*

Effective 10/13/1970 *__REGULATION NO. XII: (5)(c)__ Dissolved oxygen: Not less than 5.0 mg/l, except the swamp waters may have a minimum of 4.0 mg/l.*

Effective 12/14/1978 *__02B .0213__* **REVISIONS TO DISSOLVED OXYGEN STANDARDS**

For class "C" and "SC" waters, the commission, on its own initiative or pursuant to a request under G.S. 150A-16 by affected dischargers, may grant revisions to the dissolved oxygen standard for certain stream segments, where the commission finds that:

(1) Natural background conditions in the stream segment preclude the attainment of a daily average dissolved oxygen concentration of 5.0 mg/l; or

(2) Irretrievable an uncontrollable man-induced conditions preclude the attainment of a daily average dissolved oxygen concentration of 5.0 mg/l; or

(3) Application of effluent limitations for existing source in the stream segment more stringent than present waste treatment technology in order to attain and maintain a daily average dissolved oxygen concentration of 5.0 mg/l would result in substantial adverse economic and social impact.

Any such revisions shall be established in accordance with G.S. 143-214.1 and shall be indicated in the schedule of classifications. The revised dissolved oxygen standard shall be established at the highest level economically attainable but shall be no lower than the level attainable with the application of present waste treatment technology by dischargers to the stream segment. Dischargers to such waters shall provide treatment at least as stringent as present waste treatment technology.

Effective
9/1/1979

02B .0212 (d)(3)(C)--- *Dissolved oxygen: not less than 5.0 mg/l, except that swamp waters may have lower values if caused by natural conditions;*

Effective
10/1/1989

02B .0212 (a)(3)(B)--- *Dissolved* oxygen: *not less than 5.0 mg/l, except that swamp waters, poorly flushed tidally influenced streams or embayments, or estuarine bottom waters may have lower values if caused by natural conditions;*

02B .0213 --- **REVISIONS TO DISSOLVED OXYGEN STANDARDS** was Repealed from standards.

As In Rule
8/1/2004

02B .0220 (3)(b)---*Dissolved oxygen: not less than 5.0 mg/l, except that swamp waters, poorly flushed tidally influenced streams or embayments, or estuarine bottom waters may have lower values if caused by natural conditions;*

North Carolina's Surface Water Standard History

for

Dissolved Oxygen

Class C

11/19/1953 ***SECTION III: (CLASS C)(3)*** ---- *Dissolved oxygen: not less than 5.0 parts per million for trout producing waters; not less than 4.0 parts per million for non-trout waters, except that swamp waters may have a minimum of 3.0 parts per million.*

Effective
10/13/1970 ***REGULATION NO. XI: (8)(c)*** --- *Dissolved oxygen: not less than 6.0 mg/l for natural trout waters; 5.0 mg/l for put- and-take trout waters; not less than a daily average of 5.0 mg/l with a minimum of less than 4.0 mg/l for non-trout waters, except that swamp waters may have lower values if caused by natural conditions.*

Effective
3/1/1977 ***02B .0211 (e)(3)(C)*** --- *Dissolved oxygen: not less than 6.0 mg/l for trout waters; for non-trout waters, not less than a daily average of 5.0 mg/l with a minimum instantaneous value of less than 4.0 mg/l; Swamp waters may have lower values if caused by natural conditions. In certain stream segments where the cost of meeting the standard with treatment in excess of present waste treatment technology is economically prohibitive when compared with the expected benefits to be obtained, or the natural quality of the water or uncontrollable non-point source pollution prevents the attainment of a daily average dissolved oxygen concentration of 5.0 mg/l, exceptions to the dissolved oxygen standard shall be established on a case-by-case basis in accordance with Section 143-214.1 of the General Statutes of North Carolina. Such exceptions shall be indicated in the schedules of classifications with the revised minimum dissolved oxygen standard, which will be based on field data and/or assimilative capacity calculations and shall be established at the highest dissolved oxygen concentration attainable with application of present waste treatment technology;*

Effective 12/14/1978 <u>*02B .0213*</u> --- **REVISIONS TO DISSOLVED OXYGEN STANDARDS**

For class "C" and "SC" waters, the commission, on its own initiative or pursuant to a request under G.S. 150A-16 by affected dischargers, may grant revisions to the dissolved oxygen standard for certain stream segments, where the commission finds that:

(1) Natural background conditions in the stream segment preclude the attainment of a daily average dissolved oxygen concentration of 5.0 mg/l; or

(2) Irretrievable an uncontrollable man-induced conditions preclude the attainment of a daily average dissolved oxygen concentration of 5.0 mg/l; or

(3) Application of effluent limitations for existing source in the stream segment more stringent than present waste treatment technology in order to attain and maintain a daily average dissolved oxygen concentration of 5.0 mg/l would result in substantial adverse economic and social impact.

Any such revisions shall be established in accordance with G.S. 143-214.1 and shall be indicated in the schedule of classifications. The revised dissolved oxygen standard shall be established at the highest level economically attainable but shall be no lower than the level attainable with the application of present waste treatment technology by dischargers to the stream segment. Dischargers to such waters shall provide treatment at least as stringent as present waste treatment technology.

Effective 9/1/1979 <u>*02B .0211 (e)(3)(C)*</u> *Dissolved oxygen: not less than 6.0 mg/l for trout waters; for non- trout waters, not less than a daily average of 5.0 mg/l with a minimum instantaneous value of less than 4.0 mg/l; Swamp waters may have lower values if caused by natural conditions;*

Effective 10/1/1989 <u>*02B .0211 (a)(3)(B)*</u> *Dissolved oxygen: not less than 6.0 mg/l for trout waters; for non- trout waters, not less than a daily average of 5.0 mg/l with a minimum instantaneous value of not less than 4.0 mg/l; swamp waters, lake coves or backwaters, and lake bottom waters may have lower values if caused by natural conditions;*

<u>*02B .0213*</u> --- **REVISIONS TO DISSOLVED OXYGEN STANDARDS** was Repealed from standards.

As In Rule

8/1/2004 *<u>02B .0211 (3)(b)</u> Dissolved oxygen: not less than 6.0 mg/l for trout waters; for non-trout waters, not less than a daily average of 5.0 mg/l with a minimum instantaneous value of not less than 4.0 mg/l; swamp waters, lake coves or backwaters, and lake bottom waters may have lower values if caused by natural conditions;*

Attachment 2

EPA 2000 Saltwater DO Criterion

Table 6. Summary of Virginian Province saltwater dissolved oxygen criteria.

Endpoint	Persistent Exposure (24 h or greater continuous low DO conditions)	Episodic and Cyclic Exposure (less than 24 h duration of low DO conditions)
Juvenile and Adult Survival (minimum allowable conditions)	(1) *a limit for continuous exposure* DO = 2.3 mg/L (criterion minimum concentration, CMC)	(4) *a limit based on the hourly duration of exposure* $DO = 0.370 * \ln(t) + 1.095$ where: DO = allowable concentration (mg/L) t = exposure duration (hours)
Growth Effects (maximum conditions required)	(2) *a limit for continuous exposure* DO = 4.8 mg/L (criterion continuous concentration, CCC)	(5) *a limit based on the intensity and hourly duration of exposure* Cumulative cyclic adjusted percent daily reduction in growth must not exceed 25% $\sum_{1}^{n} \frac{t_i * 1.56 * Gred_i}{24} < 25\%$ and $Gred_i = -23.1 * DO_i + 138.1$ where: $Gred_i$ = growth reduction (%) DO_i = allowable concentration (mg/L) t_i = exposure interval duration (hours) i = exposure interval
Larval Recruitment Effects[a] (specific allowable conditions)	(3) *a limit based on the number of days a continuous exposure can occur* Cumulative fraction of allowable days above a given daily mean DO must not exceed 1.0 $\sum \frac{t_i(actual)}{t_i(allowed)} < 1.0$ and $DO_i = \frac{13.0}{(2.80 + 1.84e^{-0.10t_i})}$ where: DO_i = allowable concentration (mg/L) t_i = exposure interval duration (days) i = exposure interval	(6) *a limit based on the number of days an intensity and hourly duration pattern of exposure can occur* Maximum daily cohort mortality for any hourly duration interval of a DO minimum must not exceed a corresponding allowable days of occurrence where: Allowable number of days is a function of maximum daily cohort mortality (%) Maximum daily cohort mortality (%) is a function of DO minimum for any exposure interval (mg/L) and the duration of the interval (hours)

[a] Model integrating survival effects to maintain minimally impaired larval populations.

HALOGENATED SOLVENTS INDUSTRY ALLIANCE, INC.

1300 Wilson Boulevard, 12th Floor, Arlington, VA 22209 • (703) 741-5780 Fax: (703) 741-6077

August 31, 2006

Ms. Connie Brower
Department of Environment and Natural Resources
Division of Water Quality Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

Re: Proposed Amendments to Surface Water Quality Standards (15A NCAC 02B .0204, .0208, .0211-.0212, .0214-.0216, .0218, .0220-.0222)

Dear Ms. Brower:

The Halogenated Solvents Industry Alliance, Inc. (HSIA) appreciates the opportunity to comment on the proposed amendments to the water quality standards for perchloroethylene under Sections .0208, .0212, .0214, .0215, .0216, and .0218 of Title 15A, Chapter 02B of the North Carolina Administrative Code. HSIA represents manufacturers and users of perchloroethylene and other chlorinated solvents.

The Division's proposal would establish an allowable level of perchloroethylene of 3.3 micrograms per liter (*u*g/L) to protect human health through the consumption of fish and shellfish and would reduce the acceptable level of perchloroethylene in Class WS-I through WS-V surface waters to 0.7 *u*g/L to protect human health from water consumption. In all cases, the proposed standard is based on the use of a carcinogenic potency factor to calculate a theoretical cancer risk of one-in-one-million (10^{-6}). HSIA believes that is inappropriate to establish standards for perchloroethylene based on carcinogenicity, in light of a recently published study suggesting that the solvent does not cause cancer in humans.

The proposed standards for consumption of surface waters are equivalent to the state ground water standard established under 15A NCAC 2L .0202. The 2L standard is based on the U.S. Environmental Protection Agency's (EPA) evaluation of cancer data from laboratory animal studies. As the Division may be aware, EPA currently is updating its summary of perchloroethylene for its Integrated Risk Information System (IRIS). Among the information under review by EPA are the two enclosed publications – a review of the available epidemiology results for the solvent published in 2003 and the results of a new study of cancer incidence among dry cleaning workers in the Nordic countries. We believe that these recently published studies make a significant contribution to our understanding of the potential health effects of perchloroethylene and provide substantial argument for revision of the 2L standard and for establishment of water quality standards based on endpoints other than cancer.

The epidemiology review by Mundt *et al* incorporates information from the most recent updates of US cohorts of drycleaning workers and identifies key end points requiring further study. This review provides important background for the study by Lynge *et al* of Nordic workers published earlier this year. The Nordic study, conducted by five prominent European epidemiologists, was undertaken as a series of case-control studies nested in the cohorts of laundry and dry cleaning workers identified from 1970 census data in Denmark, Norway, Sweden, and Finland. The study design provides several advantages over earlier worker studies. First, the Nordic study covers a period when perchloroethylene was the dominant solvent, estimated to be used by 70 to 90 percent of the industry in the four countries. Second, the study includes all persons working in drycleaning in those countries in 1970. Third, by using nested case controls, the researchers were able to compare the cancer risks of drycleaners with those of laundry workers, a similar group apart from the use of solvents. In particular, cigarette smoking is equally frequent among exposed and unexposed subjects. Fourth, the information available in the population, death, and cancer registers and unique personal identifiers allowed the researchers to completely ascertain the incidence of cancer.

The Nordic researchers looked at the incidence of eight cancer types, based on the results of previous epidemiology studies and laboratory animal tests with perchloroethylene. Among the most significant findings in this latest study was the absence of an increased incidence of esophageal cancer and non-Hodgkin's lymphoma in the Nordic drycleaning workers. While cervical cancer was increased among assistants in drycleaning shops, it was not elevated in women directly involved in drycleaning, and the increase was determined by the researchers not to be related to perc exposure. The authors also observed a small increase in bladder cancer that was not associated with the length of employment (*i.e.,* degree of exposure to perc). This finding is consistent with those of previous epidemiology studies that failed to find an excess of bladder cancer among workers exposed only to perchloroethylene.

I also have enclosed a summary of the discussion of the Nordic study by the Air Toxics Science Advisory Committee established by the Oregon Department of Environmental Quality. As you will note, the Committee voted to establish its ambient benchmark for perchloroethylene based on non-cancer, rather than cancer, effects.

Please do not hesitate to contact me if you have any questions about the enclosed information. We would be happy to meet with you and your staff to discuss this information in further detail.

Sincerely,

Steve Risotto

Stephen P. Risotto
Executive Director

Enclosures

Int Arch Occup Environ Health (2003) 76: 473–491
DOI 10.1007/s00420-003-0457-2

REVIEW

Kenneth A. Mundt · Thomas Birk · Margaret T. Burch

Critical review of the epidemiological literature on occupational exposure to perchloroethylene and cancer

Received: 20 December 2002 / Accepted: 14 June 2003 / Published online: 29 July 2003

Abstract ***Objectives***: Of an estimated 500,000 workers in the USA potentially exposed to perchloroethylene (PCE), the largest share is employed in the dry-cleaning industry. PCE, a non-flammable solvent, has commercial applications as a chemical intermediate, metal degreaser and, since the 1950s, primary solvent in the dry-cleaning industry. The International Agency for Research on Cancer (IARC) currently finds sufficient evidence to designate PCE as carcinogenic in animals, with limited evidence in humans. With regard to occupational exposure through dry-cleaning, PCE is considered to be *possibly* carcinogenic to humans. This review was conducted to assess the current epidemiological literature on PCE and specific cancers. ***Methods***: A comprehensive search was conducted to identify all available epidemiological literature pertaining to the carcinogenic effects of PCE. Forty-four papers that provided reasonable data on up to 17 cancer sites were critically reviewed in the context of the available background literature for each cancer site and were assessed on the basis of specified methodological and scientific quality criteria. ***Results***: While all the epidemiological studies selected for review investigated similar exposure–health outcome relationships, there was a broad diversity of proxy measurements of exposure to PCE, as well as numerous specific cancer outcomes of interest. The widespread lack of valid exposure measurements or other adequate indicators of potential for exposure were consistent limitations. We found no evidence of an association between breast, prostate, skin or brain cancer and exposure to PCE. A relationship between PCE and cancer of the following sites was considered unlikely: oral cavity, liver, pancreas, cervix lung. Scientific evidence was inadequate for laryngeal, kidney, esophageal and bladder cancers. ***Conclusions***: The current epidemiological evidence does not support a conclusion that occupational exposure to PCE is a risk factor for cancer of any specific site. Priority areas in which additional data are most needed include cancers of the esophagus and bladder.

Keywords Perchloroethylene · Tetrachloroethylene · Critical review · Cancer

K. A. Mundt (✉) · T. Birk · M. T. Burch
Applied Epidemiology, Inc., P.O. Box 2424,
Amherst, Massachusetts, 01002-2424, USA
E-mail: kmundt@appliedepidemiology.com
Fax: +1-413-2563503

Introduction

Perchloroethylene (tetrachloroethylene, PCE), a chlorinated hydrocarbon, is a non-flammable solvent with commercial applications as a chemical intermediate, metal degreaser, and, since the 1950s, primary solvent in the dry-cleaning industry [46]. An estimated 500,000 workers in the USA are potentially exposed to PCE, of whom 119,000 to 278,000 are employed in the dry-cleaning industry [78, 94]. The highest potential for exposure occurs during operation of the machinery, primarily via inhalation and skin contact. In 1991, about one-third of the estimated 28,100 dry-cleaning plants in the USA used an open transfer process in which solvent-wet clothes were moved from washer to dryer by the operator, increasing the potential for exposure. In contrast, in 2000, less than 5% of approximately 30,000 dry-cleaning establishments still employed transfer machines. All other plants used a closed transfer process, which involves less potential for worker exposure [46].

PCE inhaled at high concentrations may be toxic to various human organ systems. Neurological effects include changes in behavior and coordination, as well as damage to the central nervous system. Damage to the liver and kidneys has also been documented [23, 95]. Exposure to PCE has shown a carcinogenic effect in some animal studies; however, the mechanistic processes that occur in some species of animals (e.g., mice) do not occur in humans, and conclusions based on animal models may be inappropriate [23, 46, 95]. The International Agency for Research on Cancer (IARC) currently finds sufficient evidence to designate PCE as carcinogenic in animals, with limited evidence in humans. With regard to occupational exposure through dry-cleaning, PCE is considered to be *possibly* carcinogenic to humans [46].

Epidemiological research concerning possible human health effects of PCE exposure was initiated when results of National Cancer Institute (NCI) research in 1977 indicated that PCE induced liver tumors in mice [46]. Two epidemiological cohort studies among US dry-cleaners were conducted by NCI and the National Institute for Occupational Safety and Health (NIOSH), with first results published in 1979 by Blair et al. [10] and in 1987 by Brown and Kaplan [21]. With few exceptions, later published risk estimates for PCE exposure (or for dry-cleaners as a surrogate for exposure) were either from population-based case–control studies or from national census-based cancer studies evaluating many different occupations and agents. Though many studies have been conducted mainly among populations that include dry-cleaning workers, several different cancer excesses have been reported, including cancer of the bladder, esophagus, large intestine, kidney (renal cell) and cervix. However, few consistent patterns have emerged. A few studies have evaluated PCE exposure among other occupational cohorts such as aircraft maintenance workers, where exposure is generally to multiple solvents. An assessment of the risks specifically associated with exposure to PCE is difficult or impossible in these studies.

This review is a critical assessment of the epidemiological literature on the possible relationship between PCE and specific cancer sites. The underlying rationale for a critical review is that the quality (inherent or for a specific purpose) of all available published papers is not equal. The synthesizing of evidence for an association between an exposure and a health outcome often leads to interpretations that are not necessarily reduced to a single quantitative result (as is the goal of meta-analysis). Conclusions based on a critical synthesis of the literature can avoid equating consistency with validity and deriving quantitative conclusions beyond what is reasonable, in view of the limitations of the literature.

Materials and methods

A comprehensive search with MEDLINE was conducted, based on the following main key words: tetrachloroethylene, laundry/dry-cleaning, and degreasing. Searches for relevant synonyms (e.g., PCE), occupations, industries, or authors, were also conducted. Bibliographies from relevant reviews and papers were checked to ensure complete identification of the pertinent literature. Preliminary screening excluded papers according to the following criteria: (1) the paper was not an epidemiological study, e.g., case reports, exposure assessments, reviews of the literature; (2) the outcome of interest was not cancer incidence or mortality; (3) the potential exposure was not occupational, e.g., environmental exposure only; (4) the paper was not in a peer-reviewed publication; or (5) the paper was a death-certificate study that presented only proportionate mortality ratios (PMRs). Seventy-eight papers published between 1963 and 2003 remained for potential inclusion in the critical review.

Two or more epidemiologists independently reviewed each paper for final inclusion. The overall strategy was to include as many studies as possible, and to identify their limitations rather than to exclude studies. Reviewers used a standard critical review instrument to ensure uniformity of evaluation.

The critical review process included the following steps:

1. An assessment of each study as to its quality, and, therefore, its ability to contribute to a critical assessment.
2. Consideration of the study results within the context of the collective literature (consistency).
3. Appraisal of the strength of the evidence for an association.
4. Derivation of conclusions based on a final assessment of all informative results.

An additional 34 papers were excluded from the full critical review for at least one of the following reasons: multiple publications involving the same study population [11, 12, 13, 21, 49, 72, 73, 78]; results of a single study were included as part of a larger multicenter study already included in the critical review [61, 66, 80]; no risk estimate was presented [6, 7, 34, 39, 40, 68, 74, 96]; the probability of any substantial PCE exposure was low or undefined and could not be determined in the study population [15, 29, 32, 35, 36, 50, 77]; PCE was one of many possible exposures without further differentiation [38, 42, 44, 51, 58, 71, 82, 97].

Forty-four articles remained for the critical review and synthesis. Among the studies selected for critical review were some that drew from the same study population, but were retained because they included unique sub-populations or contained pertinent information not otherwise reported; information from these papers was incorporated into discussions of results by study population. The 44 articles provided reasonable data on 17 cancer sites, and were critically reviewed in the context of the available background literature for each cancer site. For some cancer sites (bone, eye, thyroid) too few results were available in these articles to permit critical review.

The quality of each study was individually critiqued, and the quality and strength of evidence for an association was determined. Assessment of overall quality of studies incorporates many factors, some of which are subjective: strength of study design (including the study population definition and time period); quality of exposure assessment; validity of the outcome definition; avoidance of bias, and technical aspects of the design and analysis. The quality of exposure assessment is key to the critical review. Most of the studies included in this review defined exposure using relatively crude occupation or industry codes, either for possible PCE-exposed dry-cleaners or for a combined group of non-PCE exposed launderers and dry-cleaners, generally without information regarding exposure to specific agents. Other studies that tried to assess PCE exposure more directly often included mixtures of a variety of agents. Therefore, it was necessary for us to determine—on the basis of time period of potential exposure, exposure definition or measurement, exposure history, and knowledge of industry practices—the probability and extent for PCE exposure of a specific study population.

PCE exposure was considered "likely" if the assumption of a predominant PCE exposure for a cohort or sub-cohort seemed plausible. PCE exposure was considered "mixed" either if study subjects appeared to have been exposed to a variety of substances or if the study population included different industry or job categories. Within this "mixed" category a partial PCE exposure was considered "likely" if PCE was among the solvents or agents to which the populations or cases were exposed, and "possible" if PCE might have been among the solvents to which populations or cases were exposed, although no specific information with regard to exposure was available.

After the quality of each study had been assessed, the weight of evidence across studies was synthesized and assessed. The following were considered: number of studies of reasonable quality that were available, the general magnitude of effect, if any, and whether the results across studies were consistent. Finally, the weight of epidemiological evidence was determined to be either positive or negative, arguing for or against an association, or considered inadequate for any conclusion to be to drawn with regard to the relationship in question.

Results

The literature that was critically reviewed consisted of 12 cohort and 32 case–control studies. Of the twelve cohort studies, only four were of well-defined occupational cohorts: two dry-cleaner cohorts [16, 79] and two cohorts of aircraft workers exposed to multiple solvents [19, 89]. The two dry-cleaner cohorts were considered the most likely studies to elucidate the health effects of PCE, for, despite their limited characterization of individual exposure, they had the greatest opportunity for PCE exposure. On the other hand, they did not measure or control for behavioral risk factors (e.g., smoking, alcohol consumption), even though these are the main risk factors for some of the cancers evaluated. Details of these studies follow, and key characteristics of the cohort studies are included in Table 1.

Study summaries

Researchers at the NCI conducted a cohort study of dry-cleaners, including more than 5,000 members of a dry-cleaners' union in the state of Missouri [10, 12, 16]. The cohort was followed from 1 January 1948 or entry into the union (whichever came later) until 1 January 1979. Vital status of the cohort was updated through 31 December 1993 [16]. Using the available job titles as a surrogate for PCE exposure, the investigators made a qualitative exposure assessment. They assigned cohort members an exposure index based on job title and other external data in order to approximate exposure. Confounding due to race, gender, age, and calendar period was controlled in the analysis. Additional analyses were conducted of workers entering the union after 1960, because PCE was the predominant solvent used in the majority of shops after that time. The results of this analysis were similar to results based on all exposure groups combined for most cancer sites.

NIOSH also conducted a cohort study among members of a dry-cleaners' union [21, 49], using union records to identify 1,703 dry-cleaners (65% female) from four US states (New York, California, Illinois, and Michigan). Vital status has been updated twice by Ruder et al. [78, 79]. Cohort members exposed primarily to PCE before 1960 were followed for 56 years (1940–1996). Exposure was qualitative, indicated by union membership. Within the cohort, a subgroup primarily exposed to PCE was identified for additional analysis. This sub-cohort consisted of workers who (at the time of cohort definition) had worked only in

Table 1 Key characteristics of cohort studies included in the critical review (*NR* not reported)

Reference	Country (cancer site)	Study population/referent	Cohort size	Follow-up Start	Follow-up End
Andersen 1999 [2]	Scandinavia[a]	Laundry and dry-cleaners from census population (Denmark; Finland; Norway; Sweden)/national population rates	29,333	1970	NR[b]
Anttila 1995 [3]	Finland[a]	Employed persons exposed to three halogenated hydrocarbons/national population rates (PCE-exposed sub-cohort)	3,974 849	1967 1974	1992 1992
Blair 2003 [16]	USA[a]	Members of dry-cleaners' union (St. Louis, Missouri)/national population rates	5,369	1948	1993
Boice 1999 [19]	USA[a]	Aircraft-manufacturing workers in California/national and state populations rates (Routinely PCE-exposed sub-cohort)	77,965 2,631	1960 1960	1996 1996
Chow 1995 [24]	Sweden (esophagus)	Men employed in Sweden 1960/national population rates	NR	1961	1979
Lynge 1990 [55]	Denmark[a]	Dry-cleaning and laundry workers in Denmark/national population rates	10,600	1970	1980
Lynge 1994 [54]	Denmark[a]	Dry-cleaning and laundry workers in Denmark/national population rates	10,600	1970	1987
Malker 1984 [59]	Sweden[a]	Men employed in Sweden 1960/national population rates	NR	1961	1973
McLaughlin 1987 [63]	Sweden (kidney)	Men employed in Sweden 1960/national population rates	NR	1961	1979
McLaughlin 1987 [64]	Sweden (liver)	Men employed in Sweden 1960/national population rates	NR	1961	1979
Ruder 2001 [79]	USA[a]	Members of dry-cleaners' unions in four cities/national population rates (PCE "only" exposed sub-cohort)	1,703 622	1940	1996
Spirtas 1991 [89]	USA[a]	Civilian aircraft-maintenance workers in Utah/state population rates (Sub-cohort "ever" exposed to PCE)	14,457 851[c]	1953	1982

[a]Report includes results for more than one cancer site
[b]Denmark: 1987; Finland: 1990; Norway: 1991; Sweden: 1989
[c]From Stewart 1991 [91]

shops where PCE was the predominant solvent. Observed mortality was compared with national death rates, and was controlled for gender, race, and calendar period.

Spirtas et al. [89] and Boice et al. [19] studied aircraft maintenance employees and manufacturing workers, respectively. Both cohorts included employees almost certainly exposed to PCE; however, they were also likely exposed to other solvents. Exposure, defined by job title, was to mixed solvents, primarily trichloroethylene in the Spirtas cohort [89]. A sub-cohort of 851 employees also exposed to PCE was examined, but results were only presented for non-Hodgkin's lymphoma and multiple myeloma [91]. Blair and colleagues [15] recently published an update of this cohort through 1990, but no results specific to PCE were reported.

Boice et al. [19] identified a sub-cohort of employees routinely exposed to PCE within a large cohort of aircraft manufacturing workers exposed to a variety of compounds and estimated that 30% of these workers also had prior exposure to trichloroethylene (TCE). They reported that analyses of subgroups exposed to PCE but not TCE displayed similar patterns of mortality. Exposure assessment in this study was qualitative, based on potential for exposure in a specific job.

Several northern European studies were record-linkage studies based on census data linked with cancer registry information. Occupation or industry classification at one point in time was used as a surrogate of exposure [2, 24, 54, 55, 59, 63, 64]. These reports presented results for the combined group of laundry and dry-cleaning workers and, therefore, likely included a large proportion of subjects not exposed to PCE. The Finnish cohort [3] consisted of workers who had been biologically monitored for occupational exposures at the Finnish Institute of Occupational Health. However, the occupation or industry of these workers is not reported, no information regarding duration of exposure is available, and at least a part of the cohort was additionally exposed to other halogenated hydrocarbons.

Thirty-two case–control studies of PCE exposure and cancer incidence or mortality were critically reviewed, and details of the studies are included in Table 2. Most available case–control studies were population-based or hospital-based, not from any specific occupational groups, and evaluated the association between PCE exposure and one specified cancer site. A small number of studies evaluated multiple cancer sites.

The exposure definition in the majority of the case–control studies was self-reported employment in the laundry and dry-cleaning industries or self-reported exposures to dry-cleaning solvents, which served as surrogates for PCE exposure. Exposure prevalence for population-based study subjects was likely to be quite low, limiting study power.

The adjustment for potential confounders varied among studies, although most studies controlled for age and smoking and, depending on the specific cancer site studied, other potential risk factors as well.

Cancer summaries

Oral cancer (ICD-9:140–149)

The strongest risk factors for oral cancers (mouth, tongue, lip, pharynx) are tobacco products and alcohol. Some evidence for a dietary relationship exists, with low intake of fruits and vegetables associated with increased risk. Occupational factors contributing to cancers of the oral cavity are limited [18]. Because the association is strong between oral cancers and tobacco products and alcohol, estimates of risk that do not adequately control for these risk factors were interpreted with caution.

One of the US dry-cleaner cohorts [79], reported excess buccal and pharyngeal cancer, based on nine cases; the standardized mortality ratio (SMR) was 2.07 (95% confidence intervals (CI) 0.94–3.93). Five of the cases were cancer of the tongue among those first employed 20 or more years prior to diagnosis (SMR 5.0, 99% CI 1.62–11.68). Short-term workers (<5 years duration) were at significantly higher risk ($P<0.01$) than long-term workers. Blair et al. [12, 16] did not observe excess oral cancer mortality among dry-cleaners followed through 1993. Among the workers considered routinely exposed to PCE at an aircraft manufacturing facility, there were fewer oral cancer deaths than expected, based on two cases (SMR 0.55, 95% CI 0.07–1.99) [19].

In an early Swedish study excess risk of oral cancer was reported among laundry or dry-cleaning workers that were followed from 1961–1973 [59]. The only excess reported in a later study, for the period 1971 to 1989, was among Swedish women for cancer of the lip, based on five cases (standardized incidence ratio (SIR) 3.52, $P<0.05$) [2]. The authors note, however, that cancer of the lip is generally associated with ultraviolet radiation (in the form of sunlight) and smoking. The authors did not observe excess cancer for any site within the oral cavity in the total Nordic population or in individual country populations and found only one case of tongue cancer (SIR 0.18, $P<0.05$).

One case–control study found decreased risk of oral cancer for men and women ever employed in the job or industry category for laundry or dry-cleaning workers [45]. The adjusted odds ratio (OR) for men who ever worked in a laundry or dry-cleaning job showed the strongest negative effect (OR 0.39, 95% CI 0.17–0.88), based on eight cases. Analyses by duration of employment in another case–control study indicated decreased risk of oral cancer for those employed for 10 or more years in dry-cleaning (OR 0.4, 95% CI 0.0–31.6), based on one case; however, a small increased risk was found among those who had "ever worked" in the industry (OR 1.2, 95% CI 0.3–4.6, based on seven cases) [98]. Among those with a "probable" exposure to PCE there was a small increase in risk (OR 1.5, 95% CI 0.2–9.5).

These studies varied in their ability to assess the role of known risk factors for cancers of the oral cavity and pharynx. The cohort studies, by nature of their design, did not control for the use of tobacco and alcohol, which

Table 2 Key characteristics of case-control studies included in the critical review (*NR* not reported)

References	Country	Cases/controls	Number		Study period	
			Cases (exposed)	Controls (exposed)	Start	End
Aronson 1996 [4]	Canada	Prostate cancer cases, male residents (Montreal)/other cancer cases (not lung cancer) and population	449 (8)	2,083 (NR)	1979	1986
Asal 1988 [5]	USA	Renal-cell cancer cases, residents (Oklahoma)/hospital and population	315 (11)	649 (7)	1981	1984
Band 2000 [9]	Canada	Incident breast cancer cases, women (British Columbia)/population	995 (23)	1,020 (NR)	1988	1989
Blair 1993 [14]	USA	Non-Hodgkin's lymphoma cases, white men (Iowa, Minnesota)/population	622 (16)	1,245 (14)	1980	1983
Bond 1990 [20]	USA	Liver/biliary-tract cancer cases, male chemical workers (Michigan)/cohort	44 (6[a])	1,888 (231[a])	1940	1982
Brownson 1993 [22]	USA	Incident lung-cancer cases, white women, non-smokers (Missouri)/population	429 (30)	1,021 (39)	1986	1991
Clavel 1995 [25]	France	Hairy cell leukemia cases, 18 hospitals/hospital	291 (3)	541 (5)	1980	1990
Clavel 1998 [26]	France	Hairy cell leukemia cases, 18 hospitals, men/hospital	226 (1)	425 (2)	1980	1990
Delahunt 1995 [27]	New Zealand	Renal-cell cancer cases, men, residents/other cancer cases from the cancer registry	710 (NR)	12,756 (NR)	1978	1986
Dosemeci 1999 [28]	USA	Renal-cell cancer cases, identified through cancer registry, white men (Minnesota)/population	438 (50)	687 (76[a])	1988	1990
Gallagher 1996 [33]	Canada	Non-melanocytic skin-cancer cases, population based, men (Alberta)/population	446 (13)	406 (4)	1983	1984
Heineman 1994 [41]	USA	Brain-cancer deaths, white men (Louisiana; New Jersey; Pennsylvania)/population, deaths (except cerebral vascular, epilepsy, and suicide deaths)	300 (111)	320 (106)	1978	1981
Huebner 1992 [45]	USA	Incident oral cavity or pharynx cancer cases, four areas/population	1,114 (22)	1,268 (29)	1984	1985
Jahn 1999 [47]	Germany	Incident lung-cancer cases, women/population	686 (33)	712 (13)	1988	1993
Kaerlev 2000 [48]	Six countries	Incident small-bowel adenocarcinoma (Denmark; France; Germany; Italy; Spain; Sweden)/ population	107 (3)	2,649 (10)	1995	1997
Lynge 1995 [56]	Denmark	Primary liver and renal-cell cancer cases, laundry and dry-cleaning workers/cohort	33 (3)	165 (40)	1970	1987
Mabuchi 1985 [57]	USA	Vulvar cancer cases, hospitals in five metropolitan locations/hospital, without cancer	149 (13)	149 (3)	1972	1975
Mandel 1995 [60]	Five countries	Incident renal-cell cancer cases (USA; Germany; Denmark; Sweden; Australia)/population	1,732 (23/302[b])	2,309 (28/265[b])	1989	1991
Miligi 1999 [67]	Italy	Hematolymphopoietic malignancies, women/population	1,183 (25)	828 (NR)	NR	NR
Muscat 1998 [70]	USA	Incident lung-cancer cases, black workers, 24 hospitals[c] (various cities)/hospital, except illness connected with tobacco	550 (14[a])	386 (6[a])	1978	1996
Pesch 2000 [75]	Germany	Incident urothelial cancer cases, five regions/population	1,035	4,298	1991	1995
Pohlabeln 2000 [76]	Europe	Lung-cancer cases, 12 study centers/community and hospital controls	650 (20)	1,542 (29)	1988	1994
Schoenberg 1984 [81]	USA	Incident bladder cancer cases, white men (New Jersey)/population	658 (7)	1,258 (10)	1978	1979
Siemiatycki 1991 [83]	Canada	Male residents (Montreal)/population; other cancer cases (except lung cancer)	3,730 (54)	533[c] (NR)	1979	1985
Silverman 1983 [84]	USA	Incident bladder cancer cases, white men (Detroit, Michigan)/population	303 (12)	296 (5)	1977	1978
Silverman 1989 [85]	USA	National Bladder Cancer Study, non-white men, ten geographical areas/population	126 (11)	383 (12)	1977	1978
Silverman 1990 [86]	USA	National Bladder Cancer Study, white women, ten geographical areas/population	652 (23)	1266 (32)	1977	1978
Smith 1985 [88]	USA	Bladder cancer cases, laundry, dry-cleaning workers and others/population	NR[d]	NR[d]	1978	1978
Stemhagen 1983 [90]	USA	Incident primary liver caner, (New Jersey)/hospital, death certificate (except hepatitis, cirrhosis and other liver diseases)	265 (10)	530 (8)	1975	1980
Swanson 1995 [92]	USA	Incident cases (11 cancer locations), women, (Detroit, Michigan)/population	5714 (NR)	1972 (NR)	1984	1991
		(Bladder cancer cases)	(6)	(16)		
Teschke 1997 [93]	Canada	Incident cases bladder and nasal cancer (British Columbia)/population	153 (5)	298 (8)	1990	1992
		(Bladder cancer cases[e])	105 (5)	139 (4)		
Vaughan 1997 [98]	USA	Incident cases of the oral cavity, larynx and esophagus (Washington)/population	1120 (16)	724 (8)	1983	1990

[a]Calculated by the authors
[b]Exposed: "ever" worked in dry-cleaning/"ever" exposed to dry cleaning solvents
[c]Population controls. The study also compared other cancer cases as a control group for each site ($n = 1,360–2,864$)
[d]Smith reports number of persons according to status of exposure: (1) ever employed in laundry or dry cleaning ($n = 103$); (2) employed in other professions/industry in which similar or the same materials were used ($n = 5,776$); (3) non-exposed group ($n = 1,869$)
[e]Three cases and one control were specifically employed in dry-cleaning

for this cancer site limit the quality of the evidence. Risk estimates in the study by Vaughan et al. [98] were adjusted for smoking and alcohol; Huebner et al. [45] also controlled for tobacco and alcohol, as well as length of employment, and observed a reduced risk of cancer, though the study population included laundry and dry-cleaning workers. Because of the strength of the association between smoking and alcohol use and cancers of the oral cavity and pharynx, estimates that do not account for these risk factors must be interpreted with caution. Further, in view of the risk estimates and associated confidence intervals observed in the studies reviewed, it is unlikely that control of other risk factors would have generated positive results.

The quality of evidence available for one to understand the relationship between PCE and oral cancer is limited. Some of the study populations were likely exposed to PCE, even though the quality of the exposure information was poor. The possibility of an association between PCE exposure and oral cancer appears unlikely, given that the two case–control studies that adequately adjusted for important potential confounders found no, or only minimal, excess risk. Further, the lack of strong effects and inconsistent results in the populations restricted to dry-cleaning workers lessen support for an association between PCE and oral cancer. Other explanations for these cancers appear more likely, such as tobacco and alcohol consumption.

Digestive-tract cancers

The literature reviewed showed no evidence for cancer of the stomach or rectum. A statistically significant excess for intestinal cancer in the study by Ruder et al. [79] was restricted to the sub-cohort exposed to PCE and other solvents; all cases of rectal cancer were in this sub-cohort.

Esophageal cancer (ICD-9:150)

Risk factors for esophageal cancer include alcohol and smoking, with clear dose–response and interactive effects demonstrated [31, 69]. Estimates of the mortality from esophageal cancer attributed to smoking alone and in combination with alcohol are high, though socio-economic status and nutrition (specifically low intake of fruit and vegetables) are also considered to be important risk factors [30, 69].

Included in Table 3 are the key characteristics and estimates of effect for the studies reviewed for esophageal cancer. For most of the studies there were few cases of esophageal cancer reported. Blair et al. [16] and Ruder et al. [79] reported statistically significant excesses of esophageal cancer. Blair et al. reported a twofold increase, based on 26 deaths; 18 of those deaths occurred among black male workers (SMR 3.1; 95% CI 1.9–5.0). The authors noted that they did not observe increased

Table 3 Reported risk estimates for esophageal cancer. Includes co-variates controlled for (all estimates are controlled for age) (*NR* not reported)

Reference	Exposed population	Gender	Race	Calendar interval	Region	Smoking	Alcohol	Obs./case	Effect measurement	Risk estimate	95% CI
Cohort studies											
Blair 2003 [16]	Dry-cleaning workers	x	x	x				26	SMR	2.20*	(1.50–3.30)
	Dry-cleaning workers—black, male	x	x	x				18	SMR	3.10*	(1.90–5.00)
Boice 1999 [19]	Factory workers' routine exposure to PCE	x	x	x	x			6	SMR	1.47	(0.54–3.21)
Andersen 1999 [2]	Laundry/dry-cleaning industry—men			x	x			7	SIR	0.82	(0.33–1.70)
	Laundry/dry-cleaning industry—women			x	x			14	SIR	0.97	(0.53–1.62)
Ruder 2001 [79]	Dry-cleaning workers	x	x	x				14	SMR	2.47**	(1.35–4.14)
	Dry-cleaning workers (<5 years, latency 20+ years)	x	x	x				4	SMR	2.20	(0.59–6.13)
	Dry cleaning workers (5+ years, latency 20+ years)	x	x	x				10	SMR	5.03**	(2.41–9.47)
	Dry-cleaning workers (PCE only)	x	x	x				5	SMR	2.65	(0.85–6.20)
	Dry-cleaning workers (PCE +)	x	x	x				9	SMR	2.40*	(1.10–4.56)
Case control studies											
Siemiatycki 1991 [83]	Laundry/dry-cleaning workers—men					x	x	0	OR	–	–
Vaughan 1997 [98]	"Probable" PCE exposure	x	NR[a]	x		x	x	2	OR	6.40	(0.60–68.9)
	Dry-cleaning shops (ever)	x	NR[a]	x		x	x	2	OR	3.60	(0.50–27.0)
	Dry-cleaning shops (ever)[b]	x	NR[a]	x		x	x	2	OR	1.10	(0.20–5.70)
	Dry-cleaning workers (1–9 years)	x	NR[a]	x		x	x	2	OR	4.60	(0.50–39.4)
	Dry-cleaning workers (10+ years)	x	NR[a]	x		x	x	0	OR	–	–

$*P \le 0.05$; $**P \le 0.01$

[a] Vaughan reports that adjustment for race did not change risk estimate

[b] Adenocarcinoma

risk with increased duration or level of exposure. Ruder and colleagues reported excess esophageal cancer for the whole cohort (SMR 2.47, 99% CI 1.35–4.14) and both sub-cohorts, but only the excess among those exposed to PCE and other solvents was statistically significant (SMR 2.4, 95% CI 1.10–4.56) [79]. Risk was elevated for gender and race sub-categories, although none reached statistical significance. When analyses were stratified by latency and duration, all deaths attributed to esophageal cancer were among those in the long-latency group (20 years or more since first employment); ten of the deaths reported were for those workers whose duration of employment was at least 5 years (SMR 5.03, 99% CI 2.41–9.47) [79]. Boice et al. [19] reported a non-significant increase in esophageal cancers among routinely PCE-exposed aircraft manufacturers, based on six cases (SMR 1.47, 95% CI 0.54–3.21).

In contrast, there were fewer cases reported than expected among both men and women for the Nordic countries combined [2]. There were no cases of esophageal cancer reported among "substantially exposed" launderers and dry-cleaning workers in the Siemiatycki study (i.e., 10 or more years of accumulated exposure in the occupation occurring at least 5 years before onset of disease) [83]. Similarly, there were no cases of esophageal cancer reported by Vaughan et al. among dry-cleaning workers with at least 10 years of exposure, however, among those with probable exposure, an increased relative risk estimate was reported (OR 6.4, 95% CI 0.60, 68.9), based on two squamous cell carcinomas. Analysis for adenocarcinomas also showed no increase in risk, based on two cases [98].

The overall evidence was considered inadequate for firm conclusions to be drawn regarding esophageal cancer and exposure to PCE. The potential for estimates to be confounded by alcohol and smoking as well as the possibility for exposure to other solvents undermines the perceived relationship. Nevertheless, elevated risk estimates from the large dry-cleaner cohorts likely to have PCE exposure cannot be dismissed, especially in light of adequate latency and duration.

Liver cancer (ICD-9:155–156)

The known risk factors for liver cancer vary, depending on the type of cancer. Of hepatocellular carcinoma (HCC), 80% is associated with hepatitis B virus (HBV) [53]. Cirrhosis of the liver has also been associated with HCC, but the exact relationship between alcohol and HCC has not been established (i.e., whether alcohol is a tumor initiator or promoter is unclear). Other risk factors for primary liver cancers include aflatoxins, Thorotrast, vinyl chloride, and some steroids [53].

In the literature reviewed, two studies reported a statistically significant excess of liver cancer among workers defined as "exposed" (Table 4). A case–control study by Stemhagen et al. [90] reported an excess risk of primary liver cancers (OR 2.50, 95% CI 1.02–6.14) and

Table 4 Reported risk estimates for cancer of the liver (including co-variates controlled) (*NR* not reported)

Reference	Exposed population	Gender	Race	Calendar interval	Region	Smoking	Alcohol	Obs./case	Effect measurement	Risk estimate	95% CI
Cohort studies											
Blair 2003 [16]	Dry-cleaning workers	x	x	x				10	SMR	0.80	(0.40–1.50)
Lynge 1994 [54]	Laundry/dry-cleaning workers—women							14	SIR	2.70*	(1.50–4.50)
Andersen 1999 [2]	Laundry/dry-cleaning industry—men			x	x			11	SIR	1.26	(0.63–2.25)
	Laundry/dry-cleaning industry—women			x	x			28	SIR	1.32	(0.88–1.91)
Boice 1999 [19]	Factory workers' routine exposure to PCE	x	x	x				7	SMR	2.05	(0.83–4.23)
Ruder 2001 [79]	Dry-cleaning workers		x					1	SMR	0.16	(0.00–1.32)
Case–control studies											
Stemhagen 1983 [90]	Laundry, cleaning, other garment service[a]—men							8	OR	2.29	(0.85–6.13)
	Laundry, cleaning, other garment service[b]—men							10	OR	2.50*	(1.02–6.14)
Bond 1990 [20]	Chemical workers, PCE and others—men							6	RR	1.80	(0.80–4.30)
Lynge 1995 [56]	Laundry workers	x						17	OR	NR	NR
	Dry-cleaning workers	x						0	OR	–	–

*$P \leq 0.05$
[a]HCC
[b]Primary liver cancer

a non-significant excess of HCC (OR 2.29, 95% CI 0.85–6.13) among white men in New Jersey who had been diagnosed between 1975 and 1980. Lynge and Thygesen [55] found an excess of liver cancer among female dry-cleaners or launderers that persisted in a follow-up study [54]; however, in a nested case–control study, the excess was restricted to launderers, with no liver cancer observed among dry-cleaning workers [56]. This excess in risk restricted to Danish launderers mostly explains the slight increase found by Andersen et al. [2] for laundry and dry-cleaning workers in the Nordic countries and supports the results from Ruder et al. and Blair and colleagues, which do not suggest an association between PCE exposure and liver cancer mortality [16, 78]. Ruder et al. observed only one case in the full cohort and Blair and co-workers observed fewer cases than expected [16, 78]. Bond et al. reported a slight increase in risk for chemical workers exposed to PCE among other substances (e.g., vinyl chloride) [20], and Boice and colleagues also reported a slight increase in liver cancer, based on seven cases (SMR 2.05, 95% CI 0.83–4.23) [19].

No study was able to control adequately for potential confounding. The cohort studies, by the nature of their design, were unable to control for important confounders. Bond and colleagues [20] reviewed medical department records for alcohol use and hepatitis, but found them of limited use in controlling for confounding. Stemhagen et al. [90] collected information for smoking, alcohol, and medical history, but did not report adjusted risk estimates.

The studies that contribute most to our understanding of PCE and liver cancer are those with risk estimates that pertain to dry-cleaners alone. However, no study that included an analysis of dry-cleaners alone found an increased risk for liver cancer. The epidemiological evidence in the studies reviewed here, on balance, does not support a relationship between liver cancer and exposure to PCE.

Pancreatic cancer (ICD-9:157)

Age is an important predictor of pancreatic cancer, with most cases in the US occurring between 65 and 79 years of age. The epidemiological evidence is strongest for an association between smoking and pancreatic cancer, including evidence of a dose–response relationship [1]. In addition, there is some evidence that diet plays an etiological role, where fat and animal proteins have been implicated in increasing risk. Conversely, a decrease in risk has been observed with high intake of fruit and vegetables, which may be a reflection of a lifestyle that precludes smoking. There is little conclusive evidence of occupational risk factors for pancreatic cancer, though suggested relationships include products of incomplete combustion of petroleum, pesticides, and specific chemicals and processes (not including dry-cleaning or halogenated solvents) [1].

Five cohort studies reported excess mortality due to pancreatic cancer. The excess was not statistically significant in the study by Blair and colleagues [16] (SMR 1.1, 95% CI 0.70-1.50; 28 cases observed), Anttila et al. [3] (SMR 3.08, 95% CI 0.63–8.99), Boice and co-workers [19] (SMR 1.50, 95% CI 0.72–2.76, 10 cases) or Andersen et al. [2] (SIR 1.41, 95% CI 0.98–1.96 for men; SIR 1.02, 95% CI 0.81–1.26 for women). Ruder and colleagues found no excess among those dry-cleaners exposed only to PCE, but did report an excess among the older cohort exposed to PCE and other solvents (SMR 1.89, 95% CI 1.06–3.11), based on 15 deaths [79]. Siemiatycki observed no cases of pancreatic cancer among those in laundry and dry-cleaning occupations or industries [83].

The studies providing information regarding pancreatic cancer and PCE are limited in their results. Effects observed were not large, and all studies were not able to control for confounding, especially by smoking. Ruder et al. observed a significant excess of pancreatic cancer in the sub-cohort believed to have been exposed to PCE and other solvents, but not in the sub-cohort believed to have been exposed only to PCE. In view of the epidemiological data, the authors' inability to control adequately for confounding in the studies, and the previously mentioned limitations in exposure measurements, an association between PCE and pancreatic cancer appears unlikely.

Respiratory cancers

Laryngeal cancer (ICD-9:161) Squamous cell carcinomas are the most common histological type of cancer found in the larynx and are believed to be caused by long-term smoking. The strongest risk factor for laryngeal cancer, other than smoking, is alcohol consumption. A dose–response effect and an interactive effect have been demonstrated between smoking and alcohol consumption. Studies of diet and laryngeal cancer have demonstrated a protective effect for some nutrients [8].

In most instances results from the studies reviewed were based on few cases, and no study reported statistically significant excess for laryngeal cancer: Boice et al. observed one case and Ruder and colleagues two [19, 79]. Blair and co-workers [16] observed six cases over the extended follow up (SMR 1.7, 95% CI 0.6–3.7). All six cases were in the higher-exposure category, defined for most cohort members by job held at time of enrollment in the union (SMR 2.7, 95% CI 1.0–5.8). However, results of analyses comparing those who entered the union after 1960 with those entering before 1960 were similar. Andersen et al. reported 14 cases among Nordic men (SIR 1.26, 95% CI 0.69–2.12), nine of whom were Swedish, and six cases among female launderers or dry-cleaners (SIR 0.89, 95% CI 0.33–1.94) [2]. The case–control study by Vaughan et al. [98] found a non-significant excess for cancer of the larynx among those who ever worked in the dry-cleaning industry (OR = 2.7, 95%CI 0.6–10.9), based on five cases. Vaughan and colleagues also observed an excess among those who reported working in the industry for 10 or more years (two cases). However, when the results were stratified by probability of exposure, no excess among those considered to have a high (> 50%) probability of exposure to PCE (one case) was found [98].

An association between PCE and laryngeal cancer cannot be confirmed from the current body of epidemiological research: the number of cases in each study was extremely small, exposure assessments were limited, and other risk factors were either not controlled for or were self-reported. The available evidence, therefore, is not adequate for firm conclusions to be to drawn regarding an association between PCE exposure and laryngeal cancer.

Lung cancer (ICD-9:162) Smoking is the primary risk factor for lung cancer [17]. A strong dose–response relationship has been documented. Established occupational risk factors include specific arsenic compounds, asbestos, hexavalent chromium, bis(chloro)methyl ethers, and polycyclic aromatic hydrocarbons. Other discussed risk factors include radon, silica, ionizing radiation, and prior non-malignant lung disease (e.g., silicosis). Consumption of fruits and vegetables has been suggested to have a protective effect [17].

Slightly increased relative risks for lung cancer were found in all of the cohort studies (Table 5). Andersen et al. [2] reported a significant excess of lung cancer for both men and women classified as launderers and dry-cleaners for the Nordic countries combined. Ruder et al. [79] reported a significant increase in risk for the whole cohort of dry-cleaners. Most of the excess was found among those with 20 or more years' latency who worked for less than 5 years (SMR 1.80, 95% CI 1.23–2.55), and in the group exposed to PCE and other solvents (SMR 1.46, 95% CI 1.07–1.95). The sub-cohort exposed to PCE only, showed a small and non-significant increase in risk (SMR 1.17, 95% CI 0.71–1.83). Blair and colleagues [16] reported a small increased risk based on 125 cases (SMR 1.4, 95% CI 1.1–1.6). Stratified results based on duration or exposure were similar. No statistically significant excess of lung cancer was found in the remaining studies by Anttila et al. [3] and Boice and colleagues [19]. In a further analysis of routinely or intermittently PCE-exposed lung cancer cases from the Boice cohort, using internal referents, the risk estimates showed a negative trend with duration of exposure and were lowest in the category with 5 years or more of exposure (relative risk (RR) 0.71, 95% CI 0.49–1.02).

A significant increase of lung cancer among female never-smokers (OR 2.1, 95% CI 1.2–3.7) was reported from one case–control study, where exposure was reported as employment in the dry-cleaning industry [22]. Brownson et al. defined exposure as employment in dry-cleaning and conducted analyses that incorporated duration of employment ("high" exposure defined as more than 13.5 months of employment), but did not conduct this analysis for the lifetime non-smokers [22]. Few cases were included in the case–control studies by Siemiatycki [83] and Muscat et al. [70]; therefore, the results are difficult to interpret. Jahn et al. [47] reported results of a pooled analysis of two case–control studies in Germany. An excess risk for women in the laundry and dry-cleaning industry was found that was not significant after controlling for smoking (OR 2.0, 95% CI 0.94–4.29). The authors reported a poor response rate among controls in the larger of the studies, with an under-representation of people from the lower social class among the controls. Pohlabeln et al. [76] found a non-significant excess among non-smoking women (OR 1.83, 95% CI 0.98–3.40) in a multi-center case–control study in Europe. This study also included launderers in the exposed group, and the non-smoking cases and controls of the Jahn et al. [47] study were part of this study.

As noted before, cohort studies were not able to provide estimates of effect controlling for important confounders, specifically smoking. The case–control studies reviewed were able to control for confounding by smoking, though not by occupational factors. However, for some studies, information on potential confounders was collected from surrogates, generally next of kin, which may be susceptible to reporting bias and less accurate than information from respondents.

Small excesses of lung cancer as observed in the cohort studies reviewed are often seen in occupational cohorts and may indicate differences in smoking behavior between dry-cleaners (or launderers and dry-cleaners) and the respective reference population. Lack of control for confounding by smoking might have generated or contributed to these results. Additionally, where reported, excesses were found in groups with shorter durations of employment. The excesses observed for women in the case–control studies by Brownson et al. [22], Jahn and colleagues [47], and Pohlabeln and co-workers [76] must be considered against the background of a low prevalence of dry-cleaning occupation in the populations from which controls were drawn, and low response rate for controls in the latter two studies, as well as the limited level of exposure assessment.

Overall, the quality of epidemiological evidence for studies evaluating PCE exposure and lung cancer is limited. Because no strong excesses were observed, and not all studies reviewed had the ability to control adequately for confounding by smoking or other occupational risk factors, the results must be interpreted within the context of the known risk factors for lung cancer. In view of this and the imprecision of exposure assessment in these studies, a strong association between lung cancer and PCE or employment in dry-cleaning shops seems unlikely.

Table 5 Reported risk estimates for lung cancer (*NR* not reported)

Reference	Exposed population	Gender	Race	Calendar interval	Region	Smoking	Alcohol	Obs./case	Effect measurement	Risk estimate	95% CI
Cohort studies											
Blair 2003 [16]	Dry-cleaning workers	x	x	x				125	SMR	1.40*	(1.10–1.60)
Anttila 1995 [3]	PCE	x						5	SIR	1.92	(0.62–4.48)
Andersen 1999 [2]	Laundry/dry-cleaning industry—men			x	x			141	SIR	1.24	(1.05–1.46)
	Laundry/dry-cleaning industry—women			x	x			172	SIR	1.16	(1.00–1.35)
Boice 1999 [19]	Factory workers' routine exposure to PCE	x	x	x				46	SMR	1.08	(0.79–1.44)
Ruder 2001 [79]	Dry-cleaning workers (full cohort)	x	x	x				65	SMR	1.36*	(1.05–1.73)
	Dry-cleaning workers (<5 years, latency 20+)	x	x	x				32	SMR	1.80**	(1.23–2.55)
	Dry cleaning workers (5+ years, latency 20+)	x	x	x				26	SMR	1.36	(0.89–2.01)
	Dry-cleaning workers (PCE only)	x	x	x				19	SMR	1.17	(0.71–1.83)
	Dry-cleaning workers (PCE +)	x	x	x				46	SMR	1.46*	(1.07–1.95)
Case–control studies											
Siemiatycki 1991 [83]	Laundry/dry-cleaning workers, men—any exposure					x		12	OR	0.80	(0.40–1.50)
	Laundry/dry-cleaning workers, men—substantial exposure					x		5	OR	0.60	(0.20–1.90)
Brownson 1993 [22]	Dry-cleaning industry, high exposure (>1.125 years)—white women					x		NR	OR	2.90[a]*	(1.50–5.40)
	Dry-cleaning industry, non-smokers—white women							23	OR	2.10[a]*	(1.20–3.70)
	Dry-cleaning industry, full cohort—white women					x		30	OR	1.80[a]*	(1.10–3.00)
Muscat 1998 [70]	Dry-cleaning workers—black women					x		6[b]	OR	0.70	(0.20–2.80)
	Dry-cleaning industry—black men					x		8[b]	OR	2.30	(0.40–13.0)
Jahn 1999 [47]	Laundry/dry-cleaning workers—women					x		33	OR	2.00	(0.94–4.29)
Pohlabeln 2000[c] [76]	Laundry/dry-cleaning workers—women, non-smokers					x		19	OR	1.83	(0.98–3.40)

$*P \leq 0.05$; $**P \leq 0.01$

[a]Adjusted for age, smoking, and history of lung disease

[b]Calculated by the authors

[c]Includes cases and controls from the Jahn (1999) [47] study

Cervical cancer (ICD-9:180)

Cervical cancers are generally squamous cell carcinomas, though some are adenocarcinomas [37]. Established risk factors for cervical cancer include multiple sex partners, early sexual activity, sexually transmitted diseases (human papilloma viruses (HPVs) in particular) and low socio-economic status (SES). Smoking is considered to be a co-factor for cervical cancer [37].

All five studies with cervical cancer data reported elevated cervical cancer risk estimates, except for Boice et al. [19]. Three of the studies with elevated risk found a borderline-statistically significant association: Blair et al. [16] among dry-cleaners (SMR 1.6, 95% CI 1.0–2.3, 27 cases observed); Andersen and colleagues [2] for launderers and dry-cleaners in the Nordic countries combined (SIR 1.18, 95% CI 1.01–1.38); Ruder et al. [79] for the total cohort of dry-cleaners (SMR 1.95, 95% CI 1.0–3.4), based on ten cases. The study by Anttila et al. produced a moderately elevated risk estimate (SIR 3.2, 95% CI 0.39–11.6) but only two cases were reported [3].

Although the majority of studies reported excess cervical cancer risk, and the results appear to be consistent, there was no adjustment for potential confounders in all the studies reviewed. This lack of control for known risk factors such as HPV, sexual behavior, and SES, provide too great an opportunity for alternative explanations of the results. The mechanism and biological plausibility for a relationship between PCE and cervical cancer are weak, in view of the established risk factors for cervical cancer. Overall, the quality of epidemiological evidence for an association between cervical cancer and PCE is limited, and an association seems unlikely.

There was no evidence of an association for uterine cancer and exposure to PCE or occupation in the dry-cleaning industry.

Urinary system cancers

Bladder cancer (ICD-9:188, 189.3–189.9)

Smoking is a well-established risk factor for bladder cancer, with estimated RRs ranging from 2 to 3 [31, 87]. The main occupations or industries and exposures that have been identified as high risk include rubber and dye manufacturing, the leather industry, painting, truck drivers, aluminum, and aromatic amines [87].

Excess bladder cancer mortality was observed in both the cohort studies of dry-cleaners that were reviewed (Table 6). An excess of bladder cancer was reported by Ruder et al. [79], which was seen in the subgroup of dry-cleaning workers exposed to PCE and other solvents (SMR 3.15, 95% CI 1.51–5.79), for workers with 20 years' latency and who had worked for 5 or more years (SMR 4.31, 95% CI 1.85–8.76) and for non-white male workers (SMR 4.15, 95% CI 1.1–10.6). However, there were no cases of bladder cancer among those union members exposed only to PCE. The small increase in bladder cancer mortality observed in the Blair et al. study [16] was not statistically significant (SMR 1.3, 95% CI 0.7–2.4), nor was the excess related to PCE exposure dose-indicators (little/no vs medium/high). Boice et al. observed no excess risk for aircraft manufacturers routinely exposed to PCE, based on two cases [19]. Andersen et al. reported a slight excess among male, but not among female, laundry and dry-cleaning workers [2].

The case–control studies reviewed collected information on cigarette smoking as a potential confounder. In addition, five of the studies collected information on employment in other high-risk industries and occupations.

All the case–control studies found an excess of bladder cancer; Silverman reported a statistically significant excess (RR 2.8, 95% CI 1.1–7.4), based on 11 exposed cases (non-white, male dry-cleaners) [85]. When analyzed by duration of employment, the results showed that those with fewer than 5 years of employment showed a higher risk (RR 5.3) than those employed more than 5 years (RR 1.8) [85]. Silverman notes in the discussion section that an earlier report from the same study for white men found no excess bladder cancer risk. Pesch et al. [75] reported a significant excess of urothelium cancer among German men in the highest PCE exposure categories ("substantial" exposure: OR 1.4, 95% CI 1.0–1.9; OR 1.8, 95% CI 1.1–3.1; depending on whether job-exposure matrix (JEM) or job–task exposure matrix (JTEM) was used, both based on interview information and expert ranking). It is likely that at least part of the defined PCE-exposed population was also exposed to other agents (which were not controlled for in analysis). The case–control study by Swanson et al. [92] observed an excess of bladder cancer among women who had ever worked in dry-cleaning (OR 2.0, 95% CI 0.7–6.2). The other study that looked specifically at women was the 1990 report from Silverman [86], where a small increase in risk was observed for women who had ever worked in dry-cleaning (RR 1.4, 95% CI 0.8–2.5).

Almost all the studies that were reviewed reported an excess of bladder cancer cases, though few of these risk estimates reached statistical significance. Many of the studies reporting an excess of bladder cancer included both laundry and dry-cleaning workers. The absence of any bladder cancer cases in the Ruder et al. sub-cohort exposed primarily to PCE is inconsistent with the other findings, suggesting that some factor other than PCE had contributed to the excess bladder cancer observed in the full Ruder et al. cohort [79]. The inconsistency in effect by duration of exposure observed in the Silverman study may be due to differential exposures for short-term workers or that other uncontrolled exposures or risk factors for bladder cancer contributed to the slight excesses observed.

The imprecision of exposure measurements and the lack of control for potential confounders, specifically

Table 6 Reported risk estimates for bladder cancer and other cancers of urinary organs (*NR* not reported)

Reference	Exposed population	Gender	Race	Calendar interval	Region	Smoking	Alcohol	Obs./case	Effect measurement	Risk estimate	95% CI
Cohort studies											
Blair 2003 [16]	Dry-cleaning workers	x	x	x				12	SMR	1.30	(0.70–2.40)
Andersen 1999 [2]	Laundry/dry-cleaning industry—men		x	x	x			62	SIR	1.14	(0.87–1.46)
	Laundry/dry-cleaning industry—women		x	x	x			57	SIR	0.89	(0.68–1.16)
Boice 1999 [19]	Factory workers' routine exposure to PCE	x	x	x				2	SMR	0.70	(0.09–2.53)
Ruder 2001 [79]	Dry-cleaning workers (full cohort)	x	x	x				10	SMR	2.22*	(1.06–4.08)
	Dry-cleaning workers (PCE only)	x	x	x				0	SMR	–	–
	Dry-cleaning workers (PCE and others)	x	x	x				10	SMR	3.15**	(1.51–5.79)
	Dry-cleaning workers (< 5 years, latency 20+)							1	SMR	0.72	(0.01–5.87)
	Dry cleaning workers (5+ years, latency 20+)							8	SMR	4.31**	(1.85–8.76)
Case–control studies											
Silverman 1983 [84]	Laundry/dry-cleaning industry (ever exposed)—white men							12	OR	2.40	(0.80–6.90)
	Laundry/dry-cleaning industry (adjusted for smoking)—white men					x		12	OR	2.00	NR
Schoenberg 1984 [81]	Dry-cleaning workers (ever employed)—white men					x		7	OR	1.33	(0.50–3.58)
Smith 1985 [88]	Laundry/dry-cleaning workers (employed 10 years)—men		x			x		NR	RR	1.05	(0.63–1.76)
	Laundry/dry-cleaning workers (non-smokers)	x	x					NR	RR	1.31	(0.85–2.03)
Silverman 1989 [85]	Dry-cleaning workers—non-white men					x		11	RR	2.80*	(1.10–7.40)
Silverman 1990 [86]	Dry-cleaning workers (ever employed)—white women					x		23	RR	1.40	(0.80–2.50)
Siemiatycki 1991 [83]	Laundry/dry-cleaning industry[a]—men					x		4	OR	1.20	(0.50–3.30)
	Laundry/dry-cleaning workers[a]—men					x		7	OR	1.90	(0.90–4.20)
	Laundry/dry-cleaning industry[b]—men					x		8	OR	1.20	(0.60–2.30)
	Laundry/dry-cleaning workers[b]—men					x		10	OR	1.60	(0.90–3.10)
Swanson 1995 [92]	Dry-cleaning industry—women		x			x		6	OR	2.00	(0.70–6.20)
Teschke 1997 [93]	Laundry workers (last 20 years' employment excluded)	x				x		4	OR	1.80	(0.30–11.30)
	Laundry workers (ever employed)	x				x		5	OR	2.30	(0.40–13.90)
Pesch 2000 [75]	High PCE exposure (JEM)—men				x	x		172	OR	1.20*	(1.00–1.50)
	Substantial PCE exposure (JEM)—men				x	x		71	OR	1.40*	(1.00–1.90)
	Substantial PCE exposure (JTEM)—men				x	x		22	OR	1.80*	(1.20–1.70)

$*P \leq 0.05$; $**P \leq 0.10$

[a]Substantial exposure, controlling for coffee consumption and respondent type

[b]Any exposure, controlling for coffee consumption and respondent type

smoking in the cohort studies but also other occupational risk factors, precludes a clear understanding of the relationship between bladder cancer and PCE exposure. The available evidence is inadequate for one to draw a conclusion on the relationship between bladder cancer and PCE.

Renal cancer (ICD-9:189.0–189.2) Smoking is recognized as a risk factor for renal cancer [64]. Analgesics (specifically phenacetin) have been associated with renal-pelvis tumors and more recently with renal-cell cancer. Obesity has been consistently related to increased risk of renal-cell cancer; however, the mechanism is unclear and the effect is more pronounced among women. Other exposures that have been associated with renal-cell cancer are diet, radiation, coffee, tea, socio-economic status and genetic susceptibility [64], and results are conflicting for many occupational exposures [65, 66].

Only the multi-center case–control study by Mandel et al. [60], of men and women exposed to dry-cleaning solvents, found a statistically significant increased risk for renal-cell or kidney cancer (Table 7). Slightly elevated but not statistically significant risks were found by Ruder et al. in the full cohort and sub-cohorts, by Anttila and colleagues [3] for PCE-exposed employees from different occupations and by Blair and co-workers [16] among those considered to have higher exposure. Ruder's stratified analysis showed no evidence of increased risk with increasing latency or duration of exposure for the total cohort [79]. Six of the eight kidney cancers in the Blair et al. [16] study occurred among black workers. Boice et al. observed fewer cases than expected among workers exposed to PCE [19].

With the exception of the study by Mandel et al. [60], which reported a statistically significant increased risk for men exposed to dry-cleaning solvents (OR 1.4, 95% CI 1.10–1.70) but not for men ever employed as dry-cleaners (OR 0.9, 95% CI 0.30–2.40), all other studies that reported risk estimates by gender [2, 5, 16, 28, 56, 79] showed either a decreased or a slightly increased risk for men. However, exposure in most of these studies was not limited to either dry-cleaners or PCE exposure, and not all these studies controlled for smoking and weight.

Elevated risks for women were statistically significant in one study that presented results by gender. Mandel et al. [60] reported an increased risk for women exposed to dry-cleaning solvents (OR 1.4, 95% CI 1.0–2.7), although results for women employed as dry-cleaners were not reported. Non-significant elevated risks for female dry-cleaners were reported in the case–control study by Asal et al. [5] (OR 2.8, 95% CI 0.80–9.80) in Oklahoma, where the predominant solvent used was Stoddard solvent; in the total cohort by Ruder et al. in the report from 1994 [78] (SMR 2.41, 0.50–7.03; not reported in the 2001 update); and among black but not white women (based on three and two cases, respectively) in the study by Blair et al. [16]. There is some suggestion in the literature [28] that the effects of PCE or other solvents may be different for women than for men, based on body-fat content and renal function among other anatomical and physiological factors. Specifically, Dosemeci et al. [28] suggest that these differences may be the result of a longer "internal" exposure to solvents for women than for men; however, no increased risk was found among women exposed to PCE alone (OR 0.82, 95% CI 0.30–2.10). Additionally, Lynge et al. [56] found no cases of renal-cell cancer among female dry-cleaners in the original Danish cohort of laundry and dry-cleaner workers.

Although smoking and obesity, especially in women, have been consistently related to increased risk of renal-cell cancer, most studies did not control for these variables. When such information was collected, not all results or risk estimates were adjusted for these confounders. For example, the results presented by Delahunt et al. [27], specific to dry-cleaners, are unadjusted for smoking, though smoking-adjusted results for other occupations are discussed.

Except for in one study, the results considered in this critical analysis were not statistically significant. Those of borderline significance need to be considered with caution; the *P* value, in addition to reflecting biological variability, is also dependent on sample size and the accuracy of exposure assessment. Furthermore, the case definition was not uniform. Some studies evaluated the risk of renal-cell cancer specifically (ICD-9:189.0), while others evaluated the risk of all kidney cancers combined.

In view of the differences in case definition, the limited quality of exposure assessments, small numbers of observed cases, the heterogeneity of the results, and inconsistencies in the available literature, it is not possible for one to draw a definitive conclusion regarding the relationship between PCE and renal-cell (or the broader category of kidney) cancer. It seems unlikely that a strong association exists, as a large effect would likely have been apparent, despite the limitations of the studies reviewed. Conclusions reported in a recent review of the epidemiological literature on renal-cell cancer are consistent with these findings [62].

Other cancer sites

In the process of our review we briefly considered the results for five additional cancer sites. There was no evidence of an association for breast, prostate, skin, or brain cancers and exposure to PCE. For most of these sites a relationship between PCE and the cancer is unlikely, if one considers known risk factors and the current body of literature.

Lymphatic/hematopoietic cancers (ICD-9:200–208)

The etiology of leukemia is generally unknown, as there are a large number of recognized leukemia subtypes [52]. The occupational risk factors most commonly associated with leukemia are benzene and ionizing radiation.

Table 7 Reported risk estimates for renal cell carcinoma only (ICD9:189.0), unless specified otherwise (*NR* not reported)

Reference	Exposed population	Gender	Race	Calendar interval	Region	Smoking	Alcohol	Obs./case	Effect measurement	Risk estimate	95% CI
Cohort studies											
Blair 2003 [16]	Dry-cleaning workers	x	x	x				8	SMR	1.00[a]	(0.40–2.00)
Anttila 1995 [3]	PCE	x						2	SIR	1.82	(0.22–6.56)
Andersen 1999 [2]	Laundry/dry-cleaning industry—men			x	x			24	SIR	1.03	(0.66–1.53)
	Laundry/dry-cleaning industry—women			x	x			57	SIR	0.88	(0.67–1.15)
Boice 1999 [19]	Factory workers' routine exposure to PCE	x	x	x				2	SMR	0.69	(0.08–2.47)
Ruder 2001 [79]	Dry-cleaning workers (full cohort)	x	x	x				5	SMR	1.41[b]	(0.46–3.30)
	Dry-cleaning workers (PCE only)	x	x	x				2	SMR	1.73[b]	(0.21–6.25)
	Dry-cleaning workers (PCE +)	x	x	x				3	SMR	1.27[b]	(0.26–3.72)
Case–control studies											
Asal 1988 [5]	Dry-cleaning workers—white men					x		3	OR	0.70	(0.20–2.30)
	Dry-cleaning workers—white women					x		8	OR	2.80	(0.80–9.80)
Siemiatycki 1991 [83]	Laundry/dry-cleaning industry[c]—men					x		2	OR	2.10	(0.60–7.20)
	Laundry/dry-cleaning industry[d]—men					x		5	OR	2.00	(0.90–4.40)
	Laundry/dry-cleaning workers[d]—men					x		3	OR	1.10	(0.40–2.90)
Delahunt 1995 [27]	Dry-cleaning industry—men							NR	OR	1.92	(0.27–13.89)
Lynge 1995 [56]	Dry-cleaning workers							3	OR	0.70	(0.20–2.60)
Mandel 1995 [60]	Dry-cleaning industry, ever worked—men					x		8	RR	0.90	(0.30–2.40)
	Dry-cleaning solvents—men					x		245	RR	1.40*	(1.10–1.70)
Mandel 1995 [60]	Dry-cleaning solvents—women					x		57	RR	1.60*	(1.00–2.70)
Dosemeci 1999 [28]	PCE	x				x		50	OR	1.07	(0.70–1.60)
	PCE—women					x		8	OR	0.82	(0.30–2.10)
	PCE—men					x		42	OR	1.12	(0.70–1.70)

*$P \leq 0.05$
[a]ICD8:189
[b]ICD9:189.0–189.2
[c]Substantial exposure
[d]Any exposure

Other risk factors include certain medical treatments, some viruses and retroviruses, and smoking, due in part to components of cigarette smoke that include benzene and hydrocarbons [52].

Reported results from the reviewed studies include overall estimates for all lymphatic cancer sites and some site-specific results. The overall results do not suggest a relationship between PCE and lymphatic cancers. Similarly, results for leukemia (ICD-9:204–208) and lymphosarcoma or reticulosarcoma (ICD-9:200) are unconvincing. Reported results for non-Hodgkin's lymphoma (NHL) are not so clear, as five studies reported an excess of NHL. Spirtas et al. [89] reported a significant excess among women only (SMR 9.68, 95% CI 1.17–34.96), based on two cases, and Anttila et al. [3], Boice and co-workers [19], and Andersen et al. [2] all observed non-significant excesses (the excess in Andersen et al. was only among men). Ruder et al. [79] reported a non-significant excess based on seven NHL deaths (SMR 1.39, 95% CI 0.56–2.86). Blair et al. [16] found no association (SMR 0.9, 95% CI 0.5–1.6), on the basis of 12 cases.

Any conclusions regarding lymphatic cancer and PCE exposure need to take into account the specific subtype. The current evidence and study limitations preclude a conclusion from being made with regard to an association between PCE and lymphatic/hematopoietic cancers, and specifically with regard to a PCE-NHL association.

Discussion

Limitations of the available literature

A comprehensive search for, and systematic review of, all available epidemiological literature pertaining to the carcinogenic effects of PCE was conducted. Although the total number of published papers that met the preliminary screening criteria was relatively large (78 papers were identified), only about half of these met the more restrictive criteria that are necessary for a critical assessment. However, even among the papers meeting the criteria, no study could be considered very strong and only a few studies could make a contribution, although limited, to our understanding of the role of PCE exposure as a risk factor for cancer.

A consistent limitation among studies of PCE and cancer was the widespread lack of valid exposure measurements or any other adequate indicators of potential for PCE exposure. The majority of studies evaluated relied on crude surrogates of exposure, allowing the inclusion of a substantial number of persons with no exposure to PCE (e.g., laundry workers) or mixed exposures. While quantitative estimates of exposure may not be necessary to demonstrate the presence of an association between being a member of a working group and a cancer outcome, inaccurate classification of study subjects into "exposed" and "not exposed" categories can have a profound impact on the estimate and lead to erroneous conclusions.

The size of the population studied (or, in case–control studies, the number of cases and controls) is one of the major determinants of whether a study is able to detect and quantify an association. Larger studies generally have greater statistical power to detect an effect if present, and measures of association based on larger numbers are more precisely estimated. Many of the publications available on PCE are limited by small numbers of cases, especially when the results for specific cancer sites are isolated and examined. In addition, the total epidemiological literature concerning PCE and cancer divides fairly finely across discrete cancer sites, resulting in many small bodies of literature with little evidence for any one site.

The number of apparent publications available for critical review is effectively reduced because of overlapping populations studied, or multiple reports, such as mortality updates, on a previously studied cohort. Among sets of related results, the most recent update or the report encompassing one or more study groups was usually selected for review. Although this decision was motivated by the larger numbers of outcomes of interest in more recent updates, it is not clear that advanced studies of occupational cohorts have the greatest sensitivity to detect an effect. If, for example, an effect, noted as an excess of deaths or cases of a specific outcome, occurs on average 10 years following exposure, then follow-up of the cohort over 20 or 30 years may increase the number of deaths but dilute, or even mask, the exposure-related excess. However, without more information such as dates of actual exposure, the most appropriate period of follow-up cannot be assessed.

The specific literature on PCE-exposed occupational cohorts consists of two categories: dry-cleaners and other workers that use various solvents, including PCE. Although misclassification is likely within both categories, it is possible that dry-cleaners in specific regions during certain periods, if exposed, would be exposed to PCE. Within the dry-cleaning industry actual exposure to PCE would depend on the specific equipment that was being operated and the specific job within the shop, and some individuals would have no relevant exposure to PCE. Apart from the actual exposures, other factors likely influence the health and disease patterns of those employed within the industry. For example, in the US, employees in dry-cleaning shops are not paid well, and individuals taking these jobs are often poorly educated and of lower socio-economic status. These individuals plausibly have risk-factor profiles different from those of the general population (or whatever referent groups are used in the studies), increasing the possible influence of confounding. Specific risk factors of concern within this context include cigarette smoking, alcohol consumption, multiple sex partners, and poor diet, all of which are key risk factors for specific cancers. If these factors are not properly assessed concurrently with valid measurements of exposure within a study, then the study is not able to control for their confounding effects (i.e., separate the effects of the confounding factors from those related directly to PCE) and the results may be invalid. Control for effects of socio-economic factors is very difficult and may differ by disease (e.g., cervical cancer and multiple sex partners; respiratory cancers and smoking). Most studies reviewed, however, failed to consider important potential confounding variables, including those related to social class as well as others, possibly compromising the validity of study results.

We considered the use of meta-analytic techniques to calculate a quantitative summary result for specific cancer sites. However, in addition to the limitations already described, without exception, the heterogeneity was too great or the numbers of results too few to justify any quantitative synthesis.

The search process produced what appeared to be a substantial epidemiological literature on the carcinogenicity of PCE; however, after our critical assessment this impression was weakened and the literature provided limited support for scientific conclusions.

Key results of the critical review

While all the epidemiological studies selected for inclusion in our review investigated similar exposure–health outcome relationships, there was a broad diversity of proxy measurements of exposure to PCE, as well as numerous specific cancer outcomes of interest.

For some cancers (e.g., cervical cancer) an uncritical inspection of the published results might suggest that a consistent association exists across studies where no true association exists. However, one's inability to find homogeneity among the results of the cancer-specific literature cannot be interpreted as lack of effect. From our extensive review and efforts to synthesize the results of the relevant studies on each cancer outcome, it appears that the findings are inconsistent, a characteristic found frequently in recent epidemiological literature on cancer [43].

Although some of the published studies make a limited contribution to our understanding of the role of PCE exposure as a risk factor for cancer, none is adequately strong, nor, is the body of evidence convincingly consistent to draw firm conclusions. It appears that there is little support on which to base a conclusion that occupational exposure to PCE is a strong risk factor for cancer of any site. Further, none of the cohort studies with sub-cohorts primarily exposed to PCE demonstrated any results different from the broader cohorts with mixed exposure. This argues against any PCE-specific association. A relationship between PCE and cancer of the following sites was considered unlikely, in part due to potential confounding: oral cavity, liver, pancreas, cervix, and lung. Scientific evidence was inadequate for laryngeal, kidney, esophageal, and bladder cancer.

Nevertheless, because of a number of positive findings suggested from some of these epidemiological studies (e.g., for esophageal cancer), one cannot definitely rule out the possibility that associations between PCE and some cancers exist in humans. With considerable numbers of workers exposed to PCE, a clearer indication of human carcinogenic risk is needed, which can be seen from the current body of literature. More evidence is needed to elucidate associations, if they exist, or to demonstrate with adequate power that they do not exist. Many of the published studies were conducted under existing conditions, which themselves were inherently limiting: contexts in which no exposure measurements were available; populations in which exposure prevalence was low (compounded for rarer conditions); occupational cohorts with mixed exposures, etc.

Priority areas in which additional data are most needed include cancers of the esophagus and bladder. Such studies must improve on the exposure indicators used, have adequate sample sizes (especially adequate numbers of exposed persons with the cancers of interest), and concurrently consider the role of known risk factors for the cancers, especially those that might be correlated with employment in the industry studied or the exposure itself. As additional, clearer epidemiological evidence is produced, it can be factored into the existing body of evidence, and the conclusions regarding PCE and cancer can be reassessed. However, until such additional epidemiological evidence is available, conclusions, and subsequently decisions, must rely on existing knowledge. The current epidemiological evidence does not support a conclusion that occupational exposure to PCE is a risk factor for cancer of any specific site.

Acknowledgements This review was funded by the Halogenated Solvents Industry Alliance (HSIA), Washington, D.C., USA, and was partly based on an earlier report sponsored by the Arbeitsgemeinschaft der Metall-Berufsgenossenschaften, the Arbeitsgemeinschaft der Berufsgenossenschaften der Bauwirtschaft, the Berufsgenossenschaft der Strassen-, U-Bahnen und Eisenbahnen, the Berufsgenossenschaft der Feinmechanik und Elektrotechnik, the Forschung Textilreinigung e.V. and the Textil–und Bekleidungs-Berufsgenossenschaft (all part of the German workers' compensation insurance system). The authors wish to acknowledge Drs. Frank Bochmann, Margaret McDonald, Carol Bigelow, and Diane Mundt who provided assistance with earlier drafts of the review. We also recognize Mr. Louis Bloemen and Drs. Paul Dugard, John Tomenson, and other anonymous HSIA reviewers of the draft manuscript for their thoughtful comments and questions.

References

1. Anderson KE, Potter JD, Mack TM (1996) Pancreatic Cancer. In: Shottenfeld D, Fraumeni JF (eds) Cancer epidemiology and prevention. Oxford University Press, New York, pp 725–771
2. Andersen A, Barlow L, Engeland A, Kjaerheim K, Lynge E, Pukkala E (1999) Work-related cancer in the Nordic countries. Scand J Work Environ Health 25 [Suppl 2]:1–116
3. Anttila A, Pukkala E, Sallmen M, Hernberg S, Hemminki K (1995) Cancer incidence among Finnish workers exposed to halogenated hydrocarbons. J Occup Environ Med 37:797–806

4. Aronson KJ, Siemiatycki J, Dewar R, Gérin M (1996) Occupational risk factors for prostate cancer: Results from a case-control study in Montréal, Québec, Canada. Am J Epidemiol 143:363–373
5. Asal NR, Geyer JR, Risser DR, Lee ET, Kadamani S, Cherng N (1988) Risk factors in renal cell carcinoma. II. Medical history, occupation, multivariate analysis, and conclusions. Cancer Detect Prev 13:263–279
6. Aupérin A, Benhamou S, Ory-Paoletti, C Flamant R (1994) Occupational risk factors for renal cell carcinoma: a case-control study. Occup Environ Med 57:426–428
7. Austin H, Delzell E, Grufferman S, Levine R, Morrison AS, Stolley PD, et al. (1987) Case-control study of hepatocellular carcinoma, occupation, and chemical exposures. J Occup Med 29:665–669
8. Austin DF, Reynolds P (1996) Laryngeal cancer. In: Shottenfeld D, Fraumeni JF (eds) Cancer epidemiology and prevention. Oxford University Press, New York, pp 619–636
9. Band PR, Le ND, Fang R, Deschamps M, Gallagher RP, Yang P (2000) Identification of occupational cancer risks in British Columbia. A population-based case-control study of 995 incident breast cancer cases by menopausal status, controlling for confounding factors. J Occup Environ Med 42:284–310
10. Blair A, Decoufle P, Grauman D (1979) Causes of death among laundry and dry-cleaning workers. Am J Public Health 69:508–511
11. Blair A, Tolbert P, Thomas T, Grauman D (1986) Mortality among dry cleaners (abstract). Med Lav 77:82–83
12. Blair A, Stewart PA, Tolbert PE, Grauman D, Moran FX, Vaught J, et al. (1990) Cancer and other causes of death among a cohort of dry cleaners. Brit J Ind Med 47:162–168
13. Blair A, Linos A, Stewart PA, Burmeister LF, Gibson R, Everett G, et al. (1992) Comments on occupational and environmental factors in the origin of non-Hodgkin's lymphoma. Cancer Res 52 [Suppl]:5501s–5502s
14. Blair A, Linos A, Stewart PA, Burmeister LF, Gibson R, Everett G, et al. (1993) Evaluation of risks for non-Hodgkin's lymphoma by occupation and industry exposures from a case-control study. Am J Ind Med 23:301–312
15. Blair A, Hartge P, Stewart PA, McAdams M, Lubin J (1998) Mortality and cancer incidence of aircraft maintenance workers exposed to trichloroethylene and other organic solvents and chemicals: extended follow up. Occup Environ Med 55:161–171
16. Blair A, Petralia S, Stewart P (2003) Extended mortality follow-up of a cohort of dry cleaners. Ann Epidemiol 13:50–56
17. Blot WJ, Fraumeni JF (1996) Cancers of the lung and pleura. In: Shottenfeld D, Fraumeni JF (eds) Cancer epidemiology and prevention. Oxford University Press, New York, pp 637–665
18. Blot WJ, McLaughlin JK, Devesa SS, Fraumeni JF (1996) Cancers of the oral cavity and pharynx. In: Shottenfeld D, Fraumeni JF (eds) Cancer epidemiology and prevention. Oxford University Press, New York, pp 666–680
19. Boice JD, Marano DE, Fryzek JP, Sadler CJ, McLaughlin JK (1999) Mortality among aircraft manufacturing workers. Occup Environ Med 56:581–597
20. Bond GG, McLaren EA, Sabel FL, Bodner KM, Lipps TE, Cook RR (1990) Liver and biliary tract cancer among chemical workers. Am J Ind Med 18:19–24
21. Brown DP, Kaplan SD (1987) Retrospective cohort mortality study of dry cleaner workers using perchloroethylene. J Occup Med 29:535–541
22. Brownson R, Alavanja M, Chang J (1993) Occupational risk factors for lung cancer among non-smoking women: a case-control study in Missouri (United States). Cancer Causes Control 4:449–454
23. Calabrese EJ, Kenyon EM (1991) Air toxics and risk assessment. Lewis, Chelsea, Michigan, USA
24. Chow W-H, McLaughlin JK, Malker HSR, Linet MS, Weiner JA, Stone BJ (1995) Esophageal cancer and occupation in a cohort of Swedish men. Am J Ind Med 27:749–757
25. Clavel J, Mandereau L, Cordier S, Le Goaster C, Hémon D, Conso F, et al. (1995) Hairy cell leukaemia, occupation, and smoking. Br J Haematol 91:154–161
26. Clavel J, Mandereau L, Conso F, Limasset J-C, Pourmier I, Flandrin G, et al. (1998) Occupational exposure to solvents and hairy cell leukaemia. Occup Environ Med 55:59–64
27. Delahunt B, Bethwaite PB, Nacey JN (1995) Occupational risk for renal cell carcinoma. A case-control study based on the New Zealand cancer registry. Br J Urol 75:578–582
28. Dosemeci M, Cocco P, Chow W-H (1999) Gender differences in risk of renal cell carcinoma and occupational exposures to chlorinated aliphatic hydrocarbons. Am J Ind Med 36:54–59
29. Døssing M, Petersen KT, Vyberg M Olsen JH (1997) Liver cancer among employees in Denmark. Am J Ind Med 32:248–254
30. Ellis FH, Levitan N, Lo TCM (1991) Cancer of the esophagus. In: Holleb AI, Fink DJ, Murphy GP (eds) American Cancer Society textbook of clinical oncology. American Cancer Society, Atlanta, Georgia, USA, pp 254–262
31. Ernster VL, Cummings SR (1991) Smoking and cancer. In: Holleb AI, Fink DJ, Murphy GP (eds) American Cancer Society textbook of clinical oncology. American Cancer Society, Atlanta, Georgia, USA, pp 107–124
32. Fredriksson M, Bengtsson N-O, Hardell L Axelson O (1989) Colon cancer, physical activity, and occupational exposures. Cancer 63:1838–1842
33. Gallagher RP, Bajdik CD, Fincham S, Hill GB, Keefe AR, Coldman A, et al. (1996) Chemical exposures, medical history, and risk of squamous and basal cell carcinoma of the skin. Cancer Epidemiol Biomarkers Prev 5:419–424
34. Goldberg P, Leclerc A, Luce D, Morcet J-F, Brugère J (1997) Laryngeal and hypopharyngeal cancer and occupation: results of a case-control study. Occup Environ Med 54:477–482
35. Greenland S, Salvan A, Wegman DH, Hallock MF Smith TJ (1994) A case-control study of cancer mortality at a transformer-assembly facility. Int Arch Occup Environ Health 66:49–54
36. Guralnick L (1963) Mortality by occupation and cause of death among men 20 to 64 years of age: United States, 1950. Vital Statistics—Special Reports 53:95–97, 100, 103, 226–228
37. Gusberg SB, Runowicz CD (1991) Gynecologic cancers. In: Holleb AI, Fink DJ, Murphy GP (eds) American Cancer Society textbook of clinical oncology. American Cancer Society, Atlanta, Georgia, USA, pp 481–497
38. Hardell L, Eriksson M, Lenner P, Lundgren E (1981) Malignant lymphoma and exposure to chemicals, especially organic solvents, chlorophenols and phenoxy acids: a case-control study. Br J Cancer 43:169–176
39. Hardell L, Bengtsson NO, Honsson U, Eriksson S, Larsson LG (1984) Aetiological aspects on primary liver cancer with special regard to alcohol, organic solvents and acute intermittent porphyria—an epidemiological investigation. Br J Cancer 50:389–397
40. Harrington JM, Whitby H, Gray CN, Reid FJ, Aw TC, Waterhouse JA (1989) Renal disease and occupational exposure to organic solvents: a case referent approach. Br J Ind Med 46:643–650
41. Heineman EF, Cocco P, Gomez MR, Dosemeci M, Stewart PA, Hayes RB, et al. (1994) Occupational exposure to chlorinated aliphatic hydrocarbons and risk of astrocytic brain cancer. Am J Ind Med 26:155–169
42. Hernberg S, Korkala ML, Asikainen U, Riala R (1984) Primary liver cancer and exposure to solvents. Int Arch Occup Environ Health 54:147–153
43. Hernberg S (1998) Inconclusive cancer epidemiology. Scand J Work Environ Health 24:161–164
44. Hernberg S, Kauppinen T, Riala R, Korkala M-L, Asikainen U (1988) Increased risk for primary liver cancer among women exposed to solvents. Scand J Work Environ Health 14:356–365
45. Huebner WW, Schoenberg JB, Kelsey JL, Wilcox HB, McLaughlin JK, Greenberg RS, et al. (1992) Oral and pharyngeal cancer and occupation: a case-control study. Epidemiology 3:300–309

A-306

46. International Agency for Research on Cancer (1995) IARC monographs on the evaluation of carcinogenic risks to humans. Dry cleaning, some chlorinated solvents and other industrial chemicals. IARC Press, Lyon, France
47. Jahn I, Ahrens W, Bruske-Hohlfeld I, Kreuzer M, Mohner M, Pohlabeln H, et al. (1999) Occupational risk factors for lung cancer in women: results of a case–control study in Germany. Am J Ind Med 36:90–100
48. Kaerlev L, Teglbjaerg PS, Sabroe S, Kolstad HA, Ahrens W, Eriksson M, et al. (2000) Occupation and small bowel adenocarcinoma: a European case–control study. Occup Environ Med 57:760–766
49. Kaplan SD (1980) Dry cleaner workers exposed to perchloroethylene—a retrospective cohort mortality study (PB81-231367). National Technical Information Service, Springfield, Virginia, USA
50. Kreuzer M, Pohlabeln H, Ahrens W, Kreienbrock L, Bruske-Hohlfeld I, Jockel KH (1999) Occupational risk factors for lung cancer among young men. Scand J Work Environ Health 25:422–429
51. Lin RS, Kessler II (1981) A multifactorial model for pancreatic cancer in man. JAMA 245:147–152
52. Linet M, Cartwright R (1996) The leukemias. In: Shottenfeld D, Fraumeni JF (eds) Cancer epidemiology and prevention. Oxford University Press, New York, pp 841–892
53. London W, McGlynn K (1996) Liver cancer. In: Shottenfeld D, Fraumeni JF (eds) Cancer epidemiology and prevention. Oxford University Press, New York, pp 772–793
54. Lynge E (1994) Danish cancer registry as a resource for occupational research. J Occup Med 36:1169–1173
55. Lynge E, Thygesen L (1990) Primary liver cancer among women in laundry and dry-cleaning work in Denmark. Scand J Work Environ Health 16:108–112
56. Lynge E, Cartensen B, Andersen O (1995) Primary liver cancer and renal cell carcinoma in laundry and dry-cleaning workers in Denmark. Scand J Work Environ Health 21:293–295
57. Mabuchi K, Bross DS, Kessler II (1985) Epidemiology of cancer of the vulva. Cancer 55:1843–1848
58. Mack TM, Peters JM, Yu MC, Hanisch R, Wright WE, Henderson BE (1985) Pancreas cancer is unrelated to the workplace in Los Angeles. Am J Ind Med 7:253–266
59. Malker HSR, Weiner JA (1984) Cancer environment register. Examples of use of register-based epidemiology in occupational health (in Swedish). Arbete Hälsa 9:1–107
60. Mandel JS, McLaughlin JK, Schlehofer B, Mellemgaard A, Helmert U, Lindblad P, et al. (1995) International renal-cell cancer study. IV. Occupation. Int J Cancer 61:601–605
61. McCredie M, Stewart JH (1993) Risk factors for kidney cancer in New South Wales. IV. Occupation. Br J Ind Med 50:349–354
62. McLaughlin JK, Lipworth L (2000) Epidemiologic aspects of renal cell cancer. Semin Oncol 27:115–123
63. McLaughlin JK, Malker HSR, Stone BJ, Weiner JA, Malker BK, Ericsson JLE, et al. (1987) Occupational risks for renal cancer in Sweden. Br J Ind Med 44:119–123
64. McLaughlin JK, Malker HSR, Malker BK, Stone BJ, Ericcson JLE, Blot WJ, et al. (1987) Registry-based analysis of occupational risks for primary liver cancer in Sweden. Cancer Res 47:287–291
65. McLaughlin J, Blot W, Devesa S, Fraumeni JF (1996) Renal cancer. In: Shottenfeld D, Fraumeni JF (eds) Cancer epidemiology and prevention. Oxford University Press, New York, pp 1142–1155
66. Mellemgaard A, Engholm G, McLaughlin JK, Olsen JH (1994) Occupational risk factors for renal-cell carcinoma in Denmark. Scand J Work Environ Health 20:160–165
67. Miligi L, Costantini AS, Crosignani P, Fontana A, Masala G, Nanni O, et al. (1999) Occupational, environmental, and lifestyle factors associated with the risk of hematolymphopoietic malignancies in women. Am J Ind Med 36:60–69
68. Morton W, Marjanovic D (1984) Leukemia incidence by occupation in the Portland–Vancouver metropolitan area. Am J Ind Med 6:185–205
69. Muñoz N, Day N (1996) Esophageal cancer. In: Shottenfeld D, Fraumeni JF (eds) Cancer epidemiology and prevention. Oxford University Press, New York, pp 681–706
70. Muscat JE, Stellman SD, Richie JP, Jr., Wynder EL (1998) Lung cancer risk and workplace exposures in black men and women. Environ Res 76:78–84
71. Olsen GW, Hearn S, Cook RR, Currier MF, Allen S (1989) Mortality experience of a cohort of Louisiana chemical workers. J Occup Med 31:32–34
72. Parent ME, Siemiatycki J, Fritschi L (2000) Workplace exposures and oesophageal cancer. Occup Environ Med 57:325–334
73. Parent ME, Hua Y Siemiatycki J (2000) Occupational risk factors for renal cell carcinoma in Montreal. Am J Ind Med 38:609–618
74. Partanen T, Heikkilä P, Hernberg S, Kauppinen T, Moneta G, Ojajärvi A (1991) Renal cell cancer and occupational exposure to chemical agents. Scand J Work Environ Health 17:231–239
75. Pesch B, Haerting J, Ranft U, Klimpel A, Oelschlagel B, Schill W (2000) Occupational risk factors for urothelial carcinoma: agent-specific results from a case–control study in Germany. MURC Study Group. Multicenter Urothelial and Renal Cancer. Int J Epidemiol 29:238–247
76. Pohlabeln H, Boffetta P, Ahrens W, Merletti F, Agudo A, Benhamou E, et al. (2000) Occupational risks for lung cancer among nonsmokers. Epidemiology 11:532–538
77. Pukkala E (1995) Cancer risk by social class and occupation. A survey of 109,000 cancer cases among Finns of working age. In: Wahrendorf J (ed) Contributions to epidemiology and biostatistics. Karger, pp 62–77
78. Ruder AM, Ward EM, Brown DP (1994) Cancer mortality in female and male dry-cleaning workers. J Occup Med 36:867–874
79. Ruder AM, Ward EM, Brown DP (2001) Mortality in dry-cleaning workers: an update. Am J Ind Med 39:121–132
80. Schlehofer B, Heuer C, Blettner M, Niehoff D, Wahrendorf J (1995) Occupation, smoking and demographic factors, and renal cell carcinoma in Germany. Int J Epidemiol 24:51–57
81. Schoenberg JB, Stemhagen A, Mogleinicki AP, Altman R, Abe T, Mason T (1984) Case–control study of bladder cancer in New Jersey. I. Occupational exposures in white males. J Natl Cancer Inst 72:973–981
82. Sharpe CR, Rochon JE, Adam JM, Suissa S (1989) Case–control study of hydrocarbon exposures in patients with renal cell carcinoma. CMAJ 140:1309–1318
83. Siemiatycki J (1991) Risk factors for cancer in the workplace. CRC Press, Boca Raton, Florida, USA
84. Silverman DT, Hoover RN, Albert S, Graff KM (1983) Occupation and cancer of the lower urinary tract in Detroit. J Natl Cancer Inst 70:237–245
85. Silverman DT, Levin LI, Hoover RN (1989) Occupational risks of bladder cancer in the United States: II. Nonwhite men. J Natl Cancer Inst 81:1480–1483
86. Silverman DT, Levin LI, Hoover RN (1990) Occupational risks of bladder cancer among white women in the United States. Am J Epidemiol 132:453–461
87. Silverman DT, Morrison AS, Devesa S (1996) Bladder cancer. In: Shottenfeld D, Fraumeni JF (eds) Cancer epidemiology and prevention. Oxford University Press, New York, pp 1156–1179
88. Smith EM, Miller ER, Woolson RF, Brown CK (1985) Bladder cancer risk among laundry workers, dry-cleaners, and other chemically related occupations. J Occup Med 27:295–297
89. Spirtas R, A SP, S LJ, et al. (1991) Retrospective cohort mortality study of workers at an aircraft maintenance facility. I Epidemiological results. Br J Ind Med 48:515–530
90. Stemhagen A, Slade J, Altman R, Bill J (1983) Occupational risk factors and liver cancer. A retrospective case–control study of primary liver cancer in New Jersey. Am J Epidemiol 117:443–454
91. Stewart PA, Lee JS, Marano DE, Spirtas R, Forbes CD, Blair A (1991) Retrospective cohort mortality study of workers at an aircraft maintenance facility. II. Exposures and their assessment. Br J Ind Med 48:531–537

92. Swanson GM, Brissette Burns P (1995) Cancer incidence among women in the workplace: a study of the association between occupation and industry and 11 cancer sites. J Occup Environ Med 37:282–287
93. Teschke K, Morgan MS, Checkoway H, Franklin G, Spinelli JJ, van Belle G, et al. (1997) Surveillance of nasal and bladder cancer to locate sources of exposure to occupational carcinogens. Occup Environ Med 54:443–451
94. US Environmental Protection Agency (1998) Cleaner technologies substitutes assessment: Professional fabric care processes. Environmental Protection Agency, Washington, DC, USA
95. US Department of Health and Human Services (1997) ATSDR's toxicological profiles (book or CD-ROM). Lewis, CRC Press, Boca Raton, Florida, USA
96. Vamvakas S, Bruning T, Thomasson B, Lammert M, Baumuller A, Bolt HM, et al. (1998) Renal cell cancer correlated with occupational exposure to trichloroethene. J Cancer Res Clin Oncol 124:374–382
97. Vasama-Neuvonen K, Pukkala E, Paakkulainen H, Mutanen P, Weiderpass E, Boffetta P, et al. (1999) Ovarian cancer and occupational exposures in Finland. Am J Ind Med 36:83–89
98. Vaughan TL, Stewart PA, Davis S, Thomas DB (1997) Work in dry cleaning and the incidence of cancer of the oral cavity, larynx, and oesophagus. Occup Environ Med 54:692–695

Cancer in Persons Working in Dry Cleaning in the Nordic Countries

Elsebeth Lynge,[1] Aage Andersen,[2] Lars Rylander,[3] Håkan Tinnerberg,[3] Marja-Liisa Lindbohm,[4] Eero Pukkala,[5] Pål Romundstad,[6] Per Jensen,[1] Lene Bjørk Clausen,[1] and Kristina Johansen[1]

[1]Institute of Public Health, University of Copenhagen, Copenhagen, Denmark; [2]Cancer Registry of Norway, Oslo, Norway; [3]Department of Occupational and Environmental Medicine, Lund University Hospital, Lund, Sweden; [4]Finnish Institute of Occupational Health, Helsinki, Finland; [5]Finnish Cancer Registry, Institute for Statistical and Epidemiological Cancer Research, Helsinki, Finland; [6]Department of Community Medicine and General Practice, Norwegian University of Science and Technology, Trondheim, Norway

U.S. studies have reported an increased risk of esophageal and some other cancers in dry cleaners exposed to tetrachloroethylene. We investigated whether the U.S. findings could be reproduced in the Nordic countries using a series of case–control studies nested in cohorts of laundry and dry-cleaning workers identified from the 1970 censuses in Denmark, Norway, Sweden, and Finland. Dry-cleaning work in the Nordic countries during the period when tetrachloroethylene was the dominant solvent was not associated with an increased risk of esophageal cancer [rate ratio (RR) = 0.76; 95% confidence interval (CI), 0.34–1.69], but our study was hampered by some unclassifiable cases. The risks of cancer of the gastric cardia, liver, pancreas, and kidney and non-Hodgkin lymphoma were not significantly increased. Assistants in dry-cleaning shops had a borderline significant excess risk of cervical cancer not found in women directly involved in dry cleaning. We found an excess risk of bladder cancer (RR = 1.44; 95% CI, 1.07–1.93) not associated with length of employment. The finding of no excess risk of esophageal cancer in Nordic dry cleaners differs from U.S. findings. Chance, differences in level of exposure to tetrachloroethylene, and confounding may explain the findings. The overall evidence on bladder cancer in dry cleaners is equivocal.
Key words: cancer incidence, case–control study, dry cleaning, occupational exposure, tetrachloroethylene. *Environ Health Perspect* 114:213–219 (2006). doi:10.1289/ehp.8425 available via *http://dx.doi.org/* [Online 13 October 2005]

Previous studies of dry cleaners, primarily from the United States, indicated that exposure to tetrachloroethylene may cause an increased risk of cancer of the esophagus and cervix uteri and of non-Hodgkin lymphoma (NHL) [International Agency for Research on Cancer (IARC) 1995]. We investigated the incidence of selected cancers in Nordic dry cleaners to determine whether the U.S. findings could be reproduced in another setting.

The study was undertaken as a series of case–control studies nested in the cohorts of laundry and dry-cleaning workers identified from the 1970 censuses in Denmark, Norway, Sweden, and Finland. The cancer incidence of these cohorts has been reported previously (Andersen et al. 1999), and the Danish cohort has been used for a nested case–control study of liver and kidney cancer (Lynge et al. 1995). Use of tetrachloroethylene reached its peak in the Nordic countries around 1970 (Danmarks Statistik 2000a, 2000b, 2000c; Statistiska Centralbyrån 1995a, 1995b, 2000a, 2000b, 2000c; Statistisk Sentralbyrå 2000a, 2000b, 2000c; Tilastokeskus 2000a, 2000b, 2000c) (Figure 1); almost all of it was used for dry cleaning (Mikkelsen et al. 1983), and tetrachloroethylene was the dominant solvent in dry cleaning at the time (Anonymous 1968, 1971). Based on findings in previous studies, we included esophageal and cervical cancer and NHL (IARC 1995). We also included liver cancer found in tetrachloroethylene-exposed mice (IARC 1995), renal cell cancer found in workers exposed to trichloroethylene (Henschler et al. 1995), and bladder and pancreas cancer found in recent updates of U.S. cohorts (Blair et al. 2003; Ruder et al. 2001). Gastric cardia cancer was included because adenocarcinomas are on the increase in esophagus and cardia in some Western countries (Botterweck et al. 2000).

The purpose of this study was to determine whether dry-cleaning work in the Nordic countries around 1970, when tetrachloroethylene was the dominant dry-cleaning solvent, was associated with an increased risk of the selected cancers. We used the nested case–control design to avoid confounding from socioeconomic group and related lifestyle risk factors.

Materials and Methods

Study base, cases, and controls. The cohorts included all laundry and dry-cleaning workers from the 1970 censuses in Denmark, Finland, Norway, and Sweden. They had either the occupation code "laundry and dry-cleaning worker" or the industry code "laundry and dry cleaning" (International Labour Office 1981; Statistical Office of the United Nations 1958) (Table 1). The cohorts consisted of 46,768 persons. Each person was followed up for death, emigration, and incident cancer based on linkage with the nationwide population, death, and cancer registries using unique personal identifiers.

The present study included incident cancers of the esophagus, gastric cardia, pancreas, cervix uteri, bladder, and kidney, as well as primary liver cancer and NHL (Table 2), from the beginning of follow-up, 9 November 1970 in Denmark and 1 January 1971 in the other countries, until the end of follow-up between 1997 and 2001. Cancer cases were identified using combined topography and morphology codes from the International *Classification of Diseases for Oncology* (Percy 1990).

Controls were randomly selected from the cohort using frequency match by country, sex, 5-year age group, and 5-year calendar period at the time of diagnosis of the case. For esophageal cancer, we selected controls equal to six times the number of cases. For the other cancer sites, three times the number of cases.

The registry part of this study was approved by each of the national data protection agencies. The interview part of this study was approved by the ethics committees in Norway and Sweden; after national legislation, all participants gave active informed consent before participating in the interview.

Exposure categories. On the basis of various data sources and without knowledge of their case–control status, we categorized cases and controls as follows: *a*) exposed persons explicitly described as dry cleaners and other workers in dry-cleaning shops with < 10 workers (the latter group was included because of the shared work tasks and physical proximity in small shops); *b*) other workers in dry-cleaning shops; *c*) unexposed laundry workers and other persons not working in dry cleaning; and *d*) unclassifiable.

Exposed cases and controls were categorized by length of employment in the shop where they worked in 1970. For practical reasons, we included only the period 1964–1979. Data on smoking and alcohol drinking were collected in Norway and Sweden (Table 3).

Address correspondence to E. Lynge, Institute of Public Health, University of Copenhagen, Øster Farimagsgade 5, opg. B, Postboks 2099, DK-1014 Copenhagen K, Denmark. Telephone: 45-35-32-76-35. Fax: 45-35-32-73-83. E-mail: elsebeth@pubhealth.ku.dk

We thank the Central Bureau of Statistics in the Nordic countries for collaboration. P. Heikkilä provided the Finnish industrial hygiene data, and M. Kaurin collected the Norwegian interview data.

This study was financially supported by the Halogenated Solvents Industry Alliance, Inc. (HSIA) and the Danish Medical Research Council.

The authors received funding from the HSIA for professional services.

Received 23 June 2005; accepted 12 October 2005.

The person's specific occupational task as dry cleaner or laundry worker at the 1970 census was written in free text on the original census form. These forms were retrieved from the National Archives in Denmark and Norway. The forms had not been stored in Finland and Sweden.

A blinded personal telephone interview, eventually with a next-of-kin, was undertaken with cases and controls in Norway and Sweden. The questionnaire asked about occupational tasks in 1970, and if this was dry cleaning, then about length of employment in the shop, size of the work force, solvents used, and smoking and drinking habits. In Norway, interviews were obtained with 57% of cases (72% with next-of-kin) and with 64% of controls (42% next-of-kin). In Sweden, interviews were obtained with 63% of cases (77% next-of-kin) and with 60% of controls (39% next-of-kin). One-fourth of interviewed next-of-kin was 1970 spouses, and one-third of non-interviewed subjects had no next-of-kin.

Denmark and Finland have nationwide databases with individual records on all paid pension scheme contributions, and we used these pension scheme data for this study. In Denmark, these data started for employees in 1964; we used these data to assess length of employment and size of the work force where the employees worked in 1970. In Finland, these data started in 1962 for employees and in 1970 for self-employed persons; the data were used to assess length of employment where the persons worked in 1970. Pension scheme data were found for 91% (151 of 166) of Danish records for employees in dry cleaning, with missing data for 5 employees explained by sick leave and so on at the 1970 census. Pension scheme data were found for 75% of Finnish records.

In Denmark, we used a biography of dry-cleaning shop owners (Hammershøj 1971) and the yellow pages of local telephone books for self-employed persons to assess length of employment, with 37% from the book, 57% from telephone books, and no data for 6%. Family workers were assumed to have worked for the same length as their spouses. We used the book (Hammershøj 1971) and pension scheme data for the self-employed persons' shops to assess the size of the work force.

For Finland, we used the pension scheme data in combination with other sources (Anonymous 1984; Kyyronen et al. 1989) to assess type and size of company (Table 3). For Finland and Sweden, we coded as unexposed those cases and controls we assumed from the census codes not to be dry cleaners (e.g., "presser" in "textile industry").

We identified 1,616 cases and 2,398 controls (Table 2). Together they represented 3,883 persons. For Denmark and Norway, about 20% of the records were classified as coming from the exposed dry-cleaner group and 70–80% came from the unexposed group (Table 4). For Finland and Sweden, respectively, 41% and 35% of the records were unclassifiable as to whether the persons had dry-cleaning work in 1970.

Use of tetrachloroethylene peaked in the Nordic countries around 1970, and the compound was used almost exclusively for dry cleaning (Figure 1). In Denmark, import of the new fully automated German and English machines using tetrachloroethylene started in 1959 (Direktoratet for Arbejdstilsynet 1959). In 1967, 30% of conventional shops had machines obtained within the last 10 years (Schleisner 1967), and new coin-operated machines using only tetrachloroethylene made up 40% of the market in 1968 (Anonymous 1968).

In 1968, tetrachloroethylene constituted 75% of the solvents used for dry cleaning in Denmark, 85% in Finland, and 72% in Sweden (Anonymous 1968); in 1971 it was estimated to constitute 90% of dry-cleaning solvent used in Scandinavia (Anonymous 1971). In the questionnaires, 76% of dry cleaners in Norway and 84% in Sweden reported use of tetrachloroethylene in 1970, but information on chemicals and time periods was missing in many interviews. Tetrachloroethylene was thus clearly the dominant dry-cleaning solvent throughout our study period. Work as a dry cleaner in 1970 was therefore a good proxy for exposure to tetrachloroethylene, which is the underlying exposure variable of interest in this study. The probability of being exposed to tetrachloroethylene outside dry cleaning was extremely low because virtually all tetrachloroethylene was used in this industry (Mikkelsen et al. 1983). Available data did not allow further subdivision of dry cleaners as to whether or not they had used tetrachloroethylene. Other solvents in use were white spirit and chlorofluorocarbons (Johansen et al. 2005).

In 1970, the occupational safety limit for tetrachloroethylene was 670 mg/m^3 in Finland, 350 mg/m^3 in Denmark and Norway, and 200 mg/m^3 in Sweden. In 1980, these limits were 335, 200, and 135 mg/m^3, respectively. Only 168 tetrachloroethylene measurements were made in dry-cleaning shops in the Nordic countries between 1964 and 1979. There was a large variation in exposure level across shops; the median annual level of all measurements was, however, fairly stable during 1964–1979 (Figure 2). In the analysis, we therefore assumed exposure level to tetrachloroethylene to be constant from 1964 to 1979 and used length of employment as a proxy for relative, cumulated dose. For comparison with external data, the mean of 53 measurements of ≥ 60 min for dry cleaners was 164 mg/m^3.

Analysis. The analysis was based on records for cases and controls, because a given person could appear more than once. For a given cancer site, we used all controls fulfilling the selection criteria in the analysis. We estimated rate ratios (RRs) for dry cleaners versus unexposed controls using logistic regression adjusted for matching criteria and, where relevant, for smoking and alcohol use. For a comprehensive reporting of the data, we

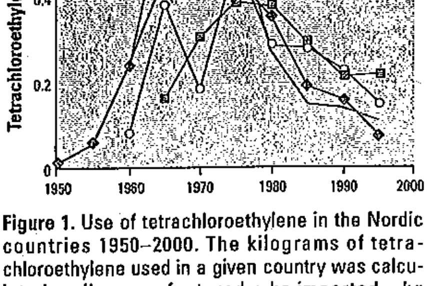


Figure 1. Use of tetrachloroethylene in the Nordic countries 1950–2000. The kilograms of tetrachloroethylene used in a given country was calculated as (kg manufactured + kg imported – kg exported). For calculation of kilograms per inhabitant per year, we divided the average tetrachloroethylene used in a 5-year period by the population size in the middle of the period.

Table 1. Industry and occupation codes in the 1970 censuses used for selection of the cohort of laundry and dry-cleaning workers in the Nordic dry-cleaner study.

	Occupation		Industry		No. of
Country	Code	Description	Code	Description	persons
Denmark	411[a]	Laundry worker, ironer	860[b]	Laundry, dry-cleaning	15,559
Finland	85[c]	Laundry and pressing	952[b]	Laundry service	6,885
Norway	95[c]	Laundering, dry-cleaning and pressing work	931[b]	Laundries and laundry service, cleaning and drying	6,874
Sweden	943[c] 944[c]	Laundry and dry-cleaning work, pressing work	9,520[b]	Laundry and dry-cleaning service	17,450
Total					46,768

[a]Special Danish occupational code (Danmarks Statistik 1974). [b]International Standard Industrial Classification (Statistical Office of the United Nations 1958). [c]Nordic Occupational Classification, which is equivalent to the International Standard Classification of Occupations (International Labour Office 1981).

also calculated the RRs for the other persons in dry cleaning and for the unclassifiable persons, although the underlying hypothesis did not include these groups. RRs were estimated for all countries together and for Denmark and Norway together. We calculated RRs for the exposed group by length of employment. We used the R survival package (R Development Core Team 2004; Therneau and Lumbley 2004) for these analyses.

Results

Eight esophageal cancer cases belonged to the dry-cleaner group, giving an RR of 0.76 [95% confidence interval (CI), 0.34–1.69] (Table 5). The estimate for Denmark and Norway gave an RR of 0.91 (95% CI, 0.38–2.20). Six exposed cases came from Denmark. Eighteen cases were unclassifiable, giving an RR of 2.04 (95% CI, 0.91–4.62); nine cases came from Finland (seven with missing pension scheme record) and nine non-interviewed cases came from Sweden. Nine gastric cardia cancer cases belonged to the dry-cleaner group, giving an RR of 0.69 (95% CI, 0.31–1.53).

Eleven exposed liver cancer cases gave an RR of 0.76 (95% CI, 0.38–1.52), and 57 exposed pancreatic cancer cases gave an RR of 1.27 (95% CI, 0.90–1.80). The highest risks were found for those with short or unknown length of employment (Table 6). Thirty-six exposed cervical cancer cases gave an RR of 0.98 (95% CI, 0.65–1.47), with the highest risk for those with short length of employment. There was a borderline significantly elevated risk of cervical cancer among other workers in dry-cleaning shops based on 22 cases, with an RR of 1.73 (95% CI, 1.00–2.97). Eleven cases were Danish (four pressers, three shop assistants, three office workers, one seamstress), seven were Finnish (six in laundries where dry cleaning was probable, one packer in a dry-cleaning shop of unspecified size), and four were Norwegian (two shop assistants, one laundry help, one spot cleaner).

Twenty-nine kidney cancer cases belonged to the dry-cleaner group, giving an RR of 0.67 (95% CI, 0.43–1.05). There was an elevated risk of bladder cancer among the dry cleaners based on 93 exposed cases (RR = 1.44; 95% CI, 1.07–1.93), with 62 exposed cases coming from Denmark and Norway, giving an RR of 1.69 (95% CI, 1.18–2.43). The risk did not increase with length of employment. Significantly elevated risks were

Table 2. Cancer cases and selected controls identified in the Nordic dry-cleaner study.

			Men					Women					
Cancer site	Topography	Morphology	Denmark	Finland	Norway	Sweden	Total	Denmark	Finland	Norway	Sweden	Total	All[a]
Esophagus	C15.0–C15.9	8000–8580[b]	15	2	3	6	26	19	12	5	10	46	72
Gastric cardia	C16.0	8000–8580[b]	10	1	2	16	29	7	4	4	6	21	50
Liver, primary	C22.0–C22.1	8000–8580[b]	9	2	2	10	23	26	16[c]	4	26	72	95
Pancreas	C25	8000–8580[b]	26	5	14	19	64	74	39	39	83	235	299
Cervix uteri	C53.0–C53.9	8000–8580[b]						128	29	44	87	288	288
Kidney	C64.9	8312.3	17	3	12	24	56	37	21	19	77	154	210
Bladder	C67	8000–8580[b]	71	4	32	70	177	60	20[c]	36	60	176	353
NHL	All	9590–9595, 9670–9698, 9711–9723[b]	18	7[c]	12	30	67	42	48[c]	30	62	182	249
Total cases			166	24	77	175	442	393	189	181	411	1,174	1,616
Controls			294	72[d]	160	291	817	537	282[d]	297	465	1,581	2,398

[a]In total, 3,883 subjects, because a given subject can be included more than once. [b]Behavior code 3 only. [c]One male NHL, one female liver, two female bladder, and one female NHL have been excluded from the analysis because there was no matching control. [d]Twelve male controls and six female controls have been excluded from the analysis because there was no matching case. Topography and morphology codes based on Percy (1990).

Table 3. Data sources used for the exposure classification in the Nordic dry-cleaner study.

Variable	Denmark	Finland	Norway	Sweden
Inclusion in the study	1970 census	1970 census	1970 census	1970 census
Occupation code in 1970	Computerized census data	Computerized census data	Computerized census data	Computerized census data
Industry code in 1970	Computerized census data	Computerized census data	Computerized census data	Computerized census data
Detailed occupation in 1970	Census forms	No data	Census forms	Interviews
Detailed industry in 1970	Census forms plus other sources[a]	Pension schemes	Census forms	Interviews
Size of the workplace where the person worked in 1970	Employees: pension schemes Self-employed plus family workers: industry book plus pension schemes	Pension schemes plus other sources[a]	Interviews	Interviews
Length of employment in the workplace where the person worked in 1970	Employees: pension schemes Self-employed plus family workers: industry book plus telephone books[b]	Pension schemes	Interviews	Interviews
Tobacco smoking and alcohol intake	No data	No data	Interviews	Interviews

[a]Questionnaire data on shop characteristics collected from employers in 1984 for a study on tetrachloroethylene and reproductive outcome (Kyyronen et al. 1989), records of persons biologically monitored for exposure at the Finnish Institute of Occupational Health, register of industrial hygiene measurements from the same institute, yearly calendars of the Finnish Association of Laundry and Dry Cleaning Employers, and a directory of Finnish companies and company facilities (Anonymous 1984). [b]All shops had a telephone, and the telephone book, in most cases, listed the telephone number together with both the name of the shop and the name of the shop owner.

Table 4. Cases and controls in the Nordic dry-cleaner study by country and exposure category.

	Denmark	Finland	Norway	Sweden	Total
Exposure category	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Unexposed	1,088 (78)[a]	234 (41)	498 (70)[b]	600 (45)	2,420 (60)
Dry cleaner and other exposed	244 (18)	41 (7)	153 (21)	257 (19)	695 (17)
Other in dry cleaning	58 (4)	62 (11)	51 (7)	12 (1)	183 (5)
Unclassifiable	0 (0)	230 (41)	13 (2)	473 (35)	716 (18)
Total	1,390 (100)	567 (100)	715 (100)	1,342 (100)	4,014 (100)

[a]Includes 12 original forms erroneously coded as laundry and dry-cleaning workers in the 1970 census. [b]Includes 55 original forms erroneously coded as laundry and dry-cleaning workers in the 1970 census.

found for 2–4 years and ≥ 10 years of employment. A similar pattern was seen when the analysis was based only on the uncensored employment periods from 1965 through 1978. The combined estimate for interviewed cases and controls from Norway and Sweden was RR = 1.34 (95% CI, 0.86–2.08), which was only slightly reduced after control for smoking (RR = 1.25; 95% CI, 0.79–1.98). The excess risk within the exposed group did not come from the owners of dry-cleaning shops and their employed dry cleaners (33 exposed cases, RR = 0.98; 95% CI, 0.64–1.51) but from the supporting staff in small shops (17 exposed cases, RR = 2.20; 95% CI, 1.18–4.11) and from owners of combined laundry and dry-cleaning shops (40 exposed cases, RR = 1.92; 95% CI, 1.23–2.98). There were 42 exposed NHL cases, giving an RR of 0.95 (95% CI, 0.65–1.41).

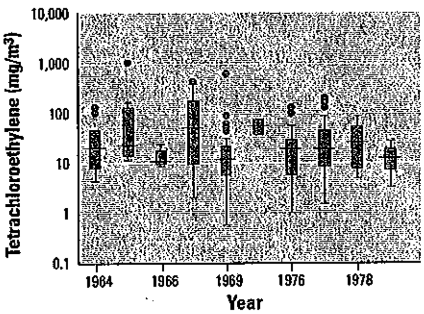


Figure 2. Tetrachloroethylene exposure in Nordic dry-cleaning shops 1964–1979. The solid line indicates median; bottoms and tops of boxes indicate 25th and 75th percentiles, respectively; bottom and top error bars indicate range, respectively; and circles indicate outliers.

Discussion

We studied the cancer risk in Nordic dry cleaners during the period where tetrachloroethylene was by far the dominant solvent, and we used laundry workers as the comparison group. Dry-cleaning work was not associated with an increased risk of esophageal cancer, but we found a borderline increased risk among persons we were unable to classify as dry cleaners or laundry workers. Dry-cleaning work was not associated with significantly increased risks of cancer of the gastric cardia, liver, pancreas, or kidney or with NHL. Female supportive staff in large dry-cleaning shops had a borderline significant excess risk of cervical cancer not found among women directly involved in dry cleaning. We found a 44% excess risk of bladder cancer among Nordic dry cleaners. The excess risk came from Denmark and Norway, the two countries with the best data. There was no clear pattern with length of employment. Adjustment for smoking in Norway and Sweden changed the estimated risk only slightly. The risk was concentrated among supporting staff in small dry-cleaning shops and among owners of combined laundry and dry-cleaning shops.

Strengths and weaknesses of the study. Our study had several advantages. First, we covered a period where tetrachloroethylene was the dominant solvent. Second, the study was nationwide, including all persons working in dry cleaning in 1970. Third, we used a series

Table 5. RRs for studied cancer sites for dry cleaners in the Nordic countries 1970–2000 in the Nordic dry-cleaner study.

	Denmark, Finland, Norway, and Sweden				Denmark and Norway only			
Cancer site	Unexposed	Dry-cleaner[a]	Other in dry-cleaning	Unclassifiable	Unexposed	Dry-cleaner[a]	Other in dry-cleaning	Unclassifiable
Esophagus								
Cases (*n*)	41	8	5	18	33	7	2	0
Controls (*n*)	342	86	31	108	242	55	20	1
RR	1	0.76	1.22	2.04	1	0.91	0.66	NR
95% CI	NR	0.34–1.69	0.41–3.63	0.91–4.62	NR	0.38–2.20	0.14–3.01	NR
Gastric cardiac								
Cases (*n*)	31	9	1	9	19	4	0	0
Controls (*n*)	201	80	8	68	125	42	7	0
RR	1	0.69	0.84	0.76	1	0.51	NR	NR
95% CI	NR	0.31–1.53	0.10–7.10	0.31–1.90	NR	0.16–1.62	NR	NR
Liver								
Cases (*n*)	58	11	2	23	36	4	1	0
Controls (*n*)	398	95	22	121	248	42	15	1
RR	1	0.76	0.42	1.11	1	0.62	0.41	NR
95% CI	NR	0.38–1.52	0.09–1.89	0.59–2.09	NR	0.21–1.89	0.05–3.25	NR
Pancreas								
Cases (*n*)	173	57	18	51	109	32	10	2
Controls (*n*)	769	206	59	242	512	112	42	1
RR	1	1.27	1.26	0.87	1	1.38	1.06	6.17
95% CI	NR	0.90–1.80	0.70–2.26	0.59–1.31	NR	0.87–2.20	0.50–2.25	0.56–68.21
Cervix								
Cases (*n*)	186	36	22	44	136	19	15	2
Controls (*n*)	744	150	51	186	516	77	34	3
RR	1	0.98	1.73	1.11	1	0.92	1.64	2.62
95% CI	NR	0.65–1.47	1.00–2.97	0.72–1.71	NR	0.54–1.59	0.87–3.11	0.42–16.26
Kidney								
Cases (*n*)	129	29	9	43	63	15	6	1
Controls (*n*)	589	196	34	241	342	99	21	3
RR	1	0.67	1.15	0.76	1	0.77	1.50	1.22
95% CI	NR	0.43–1.05	0.52–2.53	0.50–1.16	NR	0.41–1.44	0.55–4.08	0.12–12.11
Bladder								
Cases (*n*)	189	93	12	57	129	62	7	0
Controls (*n*)	904	292	52	234	639	173	38	3
RR	1	1.44	1.08	1.24	1	1.69	1.13	NR
95% CI	NR	1.07–1.93	0.55–2.11	0.83–1.83	NR	1.18–2.43	0.51–2.50	NR
NHL								
Cases (*n*)	145	42	8	52	83	16	3	0
Controls (*n*)	720	219	48	255	424	107	25	2
RR	1	0.95	0.70	0.91	1	0.73	0.64	NR
95% CI	NR	0.65–1.41	0.31–1.55	0.61–1.36	NR	0.40–1.32	0.19–2.23	NR

NR, not relevant.
[a]Includes persons stated to be dry cleaners, owners of dry-cleaning shops, and other persons employed in dry-cleaning shops with < 10 workers.

of case–control studies nested in the national cohorts of laundry and dry-cleaning workers. The cancer risks of dry cleaners were therefore compared with those of laundry workers, two groups with similar jobs apart from the use of solvents. Smoking was equally frequent among exposed (72%) and unexposed (78%) male controls in Norway, and equally so in Sweden (66% and 69%). In Norway, smoking was slightly less frequent in exposed (45%) than in unexposed (54%) women, whereas the opposite was true in Sweden (49% and 37%). Alcohol drinking was very limited, with only 4 of 675 interviewed controls reporting at least 21 drinks/week. Fourth, population, death, and cancer registries and unique personal identifiers ensured complete ascertainment of incident cancers (Pukkala et al. 2001). Fifth, all original census forms were found in Denmark and Norway, and they all included detailed job descriptions.

The study did, however, also have disadvantages. First, because of the limited data sources and mixture of processes, a high proportion of cases and controls from Sweden and Finland were unclassifiable as to whether they had dry-cleaning or laundry work in 1970. We therefore reported risk estimates for all countries and for Denmark and Norway only. Second, data on employment were available only from 1964 through 1979, but the 16-year period allowed a clear distinction to be made between short-term and stable workers. Third, the limited number of air measurements did not allow subdivision of study subjects by exposure level. However, because the data indicated a fairly stable exposure level throughout the study period, duration of employment was an acceptable proxy measure for relative cumulated dose.

Esophageal cancer. There was a clear excess risk of esophageal cancer in the two U.S. cohort studies of tetrachloroethylene-exposed dry-cleaning workers, with standardized mortality ratios (SMRs) of 2.2 (95% CI, 1.5–3.3; Blair et al. 2003) and 2.47 (95% CI, 1.35–3.14; Ruder et al. 2001), respectively. A non-significantly elevated risk was seen in the U.S. aircraft manufacturing workers exposed to tetrachloroethylene (SMR = 1.47; 95% CI, 0.54–3.21; Boice et al. 1999). Two dry cleaners with squamous cell carcinoma of the esophagus were found in a U.S. case–control study [odds ratio (OR) = 3.6; 95% CI, 0.5–27.0] (Vaughan et al. 1997).

Table 6. RRs for the studies cancer sites in dry cleaners in the Nordic countries 1970–2000 by length of employment in the Nordic dry-cleaner study.

		Dry cleaner:[a] length of employment				
Cancer site	Unexposed	0–1 year	2–4 years	5–9 years	≥ 10 years	Unknown
Esophagus						
Cases (n)	41	0	1	3	3	1
Controls (n)	261	0	5	29	27	4
RR	1	NR	1.20	0.66	0.70	1.65
95% CI	NR	NR	0.14–10.41	0.19–2.29	0.20–2.49	0.18–14.98
Gastric cardiac						
Cases (n)	31	0	0	2	6	1
Controls (n)	189	4	5	26	36	2
RR	1	NR	NR	0.46	0.97	3.00
95% CI	NR	NR	NR	0.10–2.02	0.36–2.58	0.24–38.19
Liver						
Cases (n)	58	0	0	5	5	1
Controls (n)	359	5	7	26	45	2
RR	1	NR	NR	1.21	0.70	2.88
95% CI	NR	NR	NR	0.43–3.44	0.26–1.92	0.21–38.81
Pancreas						
Cases (n)	172	6	7	14	23	7
Controls (n)	707	12	19	52	88	13
RR	1	2.14	1.38	1.18	1.20	2.44
95% CI	NR	0.76–6.06	0.54–3.50	0.62–2.25	0.72–1.99	0.90–6.66
Cervix						
Cases (n)	185	7	6	6	16	1
Controls (n)	678	8	26	47	50	3
RR	1	2.68	0.78	0.47	1.18	1.14
95% CI	NR	0.89–8.11	0.31–1.94	0.20–1.13	0.64–2.15	0.12–11.00
Kidney						
Cases (n)	125	1	4	8	14	2
Controls (n)	505	12	19	47	71	11
RR	1	0.24	0.86	0.70	0.75	0.70
95% CI	NR	0.03–2.04	0.28–2.67	0.32–1.55	0.39–1.42	0.15–3.36
Bladder[b]						
Cases (n)	188	6	10	17	53	6
Controls (n)	826	17	21	80	135	14
RR	1	1.50	2.39	0.91	1.57	1.97
95% CI	NR	0.57–3.96	1.09–5.22	0.52–1.59	1.07–2.29	0.64–6.05
NHL						
Cases (n)	145	5	3	14	15	5
Controls (n)	632	13	18	60	94	14
RR	1	1.35	0.61	0.92	0.66	1.47
95% CI	NR	0.44–4.14	0.17–2.21	0.49–1.72	0.36–1.22	0.49–4.47

NR, not relevant.
[a]Includes persons stated to be dry cleaners, owners of dry-cleaning shops, and other persons employed in dry-cleaning shops with < 10 workers. [b]Analysis based only on the uncensored employment periods from 1965 through 1978 gave the following RRs: 0–1 year = 1.43 (95% CI, 0.52–3.97); 2–4 years = 2.38 (95% CI, 1.08–5.24); 5–9 years = 1.21 (95% CI, 0.58–2.50); ≥ 10 years = 2.84 (95% CI, 0.97–8.35); unknown = 2.12 (95% CI, 0.65–6.85).

Our estimated risk of esophageal cancer after dry-cleaning work in the Nordic countries of RR = 0.76 (95% CI, 0.34–1.69) is in contrast with the U.S. findings (Blair et al. 2003, Ruder et al. 2001), although the difference in the outcome of the four studies could be due to chance. No case of esophageal cancer was found in a small Finnish cohort (Anttila et al. 1995). Unfortunately, in our study 18 cases were unclassifiable, and they had a statistically nonsignificantly increased risk (RR = 2.04; 95% CI, 0.91–4.62). We know little about these cases. However, even in the extreme and unlikely situation where all unclassifiable persons were exposed, our risk estimate would be RR = 1.19 (95% CI, 0.67–2.12). If all unclassifiable persons were unexposed, our risk estimate for the exposed group would be RR = 0.66 (95% CI, 0.30–1.45).

The excess risk of esophageal cancer in U.S. dry cleaners (Blair et al. 2003, Ruder et al. 2001) but not found in Nordic dry cleaners may be due to chance, different confounders, and/or different exposures. Esophageal cancer is associated with smoking, alcohol consumption, hot drinks, and poor nutrition (Muños and Day 1996). The mortality of the U.S. dry cleaners (Blair et al. 2003, Ruder et al. 2001) was compared with that of the national population, without control for possible confounders. However, national smoking data showed laundry and dry-cleaning workers to be only marginally more frequent smokers than the general U.S. population (Blair et al. 2003; Ruder et al. 2001), but the average earning of dry cleaners was only two-thirds of the average for private sector workers (Blair et al. 2003). We used laundry workers with similar jobs apart from the solvents as the comparison group. The self-employed Danish dry cleaners were members of Lions Club, Rotary, and so forth (Hammershøj 1971).

In 1991, about one-third of U.S. dry-cleaning plants used an open transfer process where solvent-wet clothes were manually moved from washer to dryer (Mundt et al. 2003). Based on large U.S. samples of time-weighted-average measurements for machine operators from the 1980s, the exposure level was higher at transfer machines than at dry-to-dry machines: mean concentrations were

338 mg/m^3 and 157 mg/m,^{3} respectively (IARC 1995). This transfer process was not needed in the Danish, widely exported, semi-automated machines used since the 1930s (Ingvordsen 1975), and manual handling of wet clothes became prohibited in 1953 (Arbejds-og Fabrikstilsynet 1953). The mean concentration of Nordic measurements ≥ 60 min for machine operators from 1980 through 1990 was 95 mg/m^3. The currently recommended threshold from the American Conference of Governmental Industrial Hygienists is 170 mg/m^3 [Occupational Safety and Health Administration (OSHA) 2005], whereas the current safety limit is 70 mg/m^3 in Denmark, Finland, and Sweden and 40 mg/m^3 in Norway (Arbejdstilsynet 2002, 2003; Ministry of Social Affairs and Health 2005; Swedish National Board of Occupational Safety and Health 1997). U.S. dry cleaners thus had a higher probability of dermal tetrachloroethylene exposure than did Nordic dry cleaners, and they were very probably exposed to a higher air concentration. Differences in exposure to tetrachloroethylene along with differences in socioeconomic status may therefore have contributed to the excess risk of esophageal cancer found in U.S. but not in Nordic dry cleaners.

Other cancers. Data on primary liver cancer were reported in only two U.S. studies (Blair et al. 2003; Ruder et al. 2001) with no excess risk. This is in line with the present result.

One U.S. dry-cleaner cohort had a borderline excess risk of pancreatic cancer (SMR = 1.53; 95% CI, 0.91–2.42; Ruder et al. 2001), as did aircraft manufacturing workers (SMR = 1.50; 95% CI, 0.72–2.76; Boice et al. 1999). However, the other U.S. dry-cleaner cohort (Blair et al. 2003), the Finnish cohort (Anttila et al. 1995), and the present study did not confirm this finding.

The two U.S. dry-cleaner cohorts had excess risks of cervical cancer (Ruder et al. 2001: SMR = 1.95; 95% CI, 1.00–3.40; Blair et al. 2003: SMR = 1.6; 95% CI, 1.0–2.3), an observation confirmed in the Finnish cohort based on small numbers (Anttila et al. 1995) but not among the U.S. aircraft workers (Boice et al. 1999). In U.S. dry cleaners, the risk was increased both for work with tetrachloroethylene only and for mixed solvents (Ruder et al. 2001), and the risk did not vary with exposure status (Blair et al. 2003). In our study, dry cleaners had no excess risk of cervical cancer (RR = 0.98; 95% CI, 0.65–1.47). There was, however, a borderline significant elevated risk among supporting staff in larger dry-cleaning shops (RR = 1.73; 95% CI, 1.00–2.97). We thus confirmed previous findings of an excess risk of cervical cancer among women in dry-cleaning shops, but the fact that they were not engaged in the dry-cleaning process did not point to tetrachloroethylene as the explanatory risk factor, nor did it point to social class, because the comparison group was laundry workers.

Kidney cancer was not increased in the previous cohort studies (Blair et al. 2003; Boice et al. 1999; Ruder et al. 2001) or in our study.

The risk of bladder cancer was increased in one U.S. dry-cleaner cohort (SMR = 2.22; 95% CI, 1.06–4.08; Ruder et al. 2001) but not in the other (SMR = 1.3; 95% CI, 0.7–2.4; Blair et al. 2003) and not in aircraft workers (Boice et al. 1999). The Finnish study did not report on bladder cancer (Anttila et al. 1995). The excess risk in the United States was limited to those working with mixed solvents (Ruder et al. 2001), found only in whites, and equally so in those with little or no exposure and those with medium or exposure (Blair et al. 2003). The U.S. bladder cancer case–control study reported an excess risk for dry-cleaning work in nonwhite men (OR = 2.80; 95% CI, 1.10–7.40; Silverman et al. 1989a) but not in white women (OR = 1.40; 95% CI, 0.80–2.50; Silverman et al. 1990), and data were not reported for white men (Silverman et al. 1989b). The risks for all laundry and dry cleaners of both sexes and races were 1.31 (95% CI, 0.85–2.03) for nonsmokers, 2.99 (95% CI, 1.80–4.97) for former smokers, and 3.94 (95% CI, 2.39–6.51) for current smokers (Smith et al. 1985). The joint analysis of European case–control studies showed a smoking-adjusted RR of 1.24 (95% CI, 0.67–2.31) for male launderers, dry cleaners, and pressers (Kogevinas et al. 2003). The case–control study from Montreal, Canada, gave an RR of 1.6 (90% CI, 0.9–3.1) for launderers and dry cleaners, but the risk was not elevated for exposure to tetrachloroethylene (Siemiatycki 1991). We found an elevated bladder cancer risk among dry cleaners (RR = 1.44; 95% CI, 1.07–1.93) that did not increase with length of employment. Taking the studies together, there appears to be an excess risk of about 45%, which does not seem to be explained by excessive smoking. The risk does not vary with the exposure indices. Overall, the current picture of the association between dry-cleaning work with tetrachloroethylene and risk of bladder cancer is equivocal.

In a 1995 monograph on dry cleaning (IARC 1995), an excess risk of NHL was described based on studies then available (Anttila et al. 1995; Blair et al. 1990; Boice et al. 1999). However, whereas the previous analysis of the largest cohort included only *International Classification for Diseases*, version 8 [ICD-8; World Health Organization (WHO) 1965] code 200 (Blair et al. 1990), the update included ICD-8 codes 200 and 202 (Blair et al. 2003), showing no excess risk. At present, the three studies together give 22 observed cases and 18.80 expected. Our results are in line with this.

Conclusion

Dry-cleaning work in the Nordic countries, during a period when tetrachloroethylene was the dominant solvent, was not associated with significantly increased risks of cancer of the gastric cardia, pancreas, or kidney or with primary liver cancer or NHL. Dry-cleaning work was not associated with an increased risk of esophageal cancer, but our study was hampered by some unclassifiable cases. The result for esophageal cancer contrasts findings from U.S. tetrachloroethylene-exposed cohorts, which could be due to chance, confounding, or differences in exposure level. In line with findings from previous studies, our study indicated an excess risk of cervical cancer in supporting staff in larger dry-cleaning shops, but not in women directly involved in dry cleaning. We found an elevated risk of bladder cancer among Nordic dry cleaners. The international data together point to an excess risk of bladder cancer in dry cleaners of about 45%, but there is no pattern with exposure indices. The evidence for an association between exposure to tetrachloroethylene and risk of bladder cancer is equivocal.

References

Andersen A, Barlow L, Engeland A, Kjaerheim K, Lynge E, Pukkala E. 1999. Work-related cancer in the Nordic countries. Scand J Work Environ Health 25(suppl 2):1–116.

[Anonymous.] 1968. Strukturforhold og arbejdsteknik indenfor kemisk rensning i andre lande [in Danish]. Nordisk Tidsskrift for Rensning, Farvning og Vask 80(February):21–26.

[Anonymous.] 1971. Moderne rensevæsker staves: PER og TRI, -men [in Danish]. Nordisk Tidsskrift for Rensning, Farvning og Vask 83(July):16–19.

[Anonymous.] 1984. The Blue Book XVII. A Basic Directory of Finlands' Business Life. Kajaani, Finland:Kainuun Sanomain Kirjapaino.

Anttila A, Pukkala E, Riala R, Sallmen M, Hemminki K. 1995. Cancer incidence among Finnish workers exposed to halogenated hydrocarbons. J Occup Environ Med 37:797–806.

Arbejds-og Fabriktilsynet. 1953. Regler for Kemiske Tøjrenserier, der Anvender Triklorætylen (Tri), Tetraklorætylen = Perklorætylen (Per) eller Lignende Sundhedsfarlige Rensemidler [in Danish]. Copenhagen:Arbejds-og Fabrikstilsynet, 1953.

Arbejdstilsynet. 2003. Administrative normer for forurensning i arbeidsatmosfære. Veiledning til arbeidsmiljøloven [in Norwegian]. Oslo:Arbeidstilsynet. Available: www.arbeidstilsynet.no/regelverk/veiledninger/pdf/361.pdf [accessed 21 December 2005].

Arbejdstilsynet. 2002. At-vejledninger. Grænseværdier for stoffer og materialer [in Danish]. Copenhagen:Arbejdstilsynet. Available: http://www.at.dk/graphics/at/pdf/at-vejledninger/gv-liste-april-2005.pdf [accessed 20 December 2005].

Blair A, Petralia SA, Steward PA. 2003. Extended mortality follow up of a cohort of dry cleaners. Am Epidemiol 13:50–56.

Blair A, Stewart PA, Tolbert PE, Grauman D, Moran FX, Vaught J, et al. 1990. Cancer and other causes of death among a cohort of dry cleaners. Br J Ind Med 47:162–168.

Boice JD Jr, Marano DE, Fryzek JP, Sadler CJ, McLaughlin JK. 1999. Mortality among aircraft manufacturing workers. Occup Environ Med 56:581–597.

Botterweck AA, Schouten LJ, Volovics A, Dorant E, van Den Brandt PA. 2000. Trends in incidence of adenocarcinoma of the oesophagus and gastric cardia in ten European countries. Int J Epidemiol 29:645–654.

Danmarks Statistik. 1974. Folke-og Boligtaellingen 9. November 1970 CI. Beskaeftigelse og erhverv. Copenhagen:Danmarks Statistik.

Danmarks Statistik. 2000a. Manufactures' sales of commodities 1999 [in Danish]. Copenhagen:Danmarks Statistik.

Danmarks Statistik. 2000b. External Trade 1999 [in Danish]. Copenhagen:Danmarks Statistik.
Danmarks Statistik 2000c. Statistics for the Danish Populations. Available: http://www.statistikbanken.dk/statbank5a/default.asp?w = 1024 [accessed 7 May 2003].
Direktoratet for Arbejdstilsynet 1959. Renseanlæg (rensemaskine) af Engelsk Fabrikat "Spencer," Model "Senior" og "Junior" for Perkloræthylen [in Danish]. Tillæg til R85/1953. Rundskrivelse nr. 75/1959. Copenhagen:Direktoratet for Arbejdstilsynet.
Hammershøj E. De Danske Vaskeri-og Renserierhverv. 1971 [in Danish]. København:Lieber.
Henschler D, Vamvakas S, Lammert M, Dekant W, Kraus B, Thomas B, et al. 1995. Increased incidence of renal cell tumours in a cohort of cardboard workers exposed to trichloroethylene. Arch Toxicol 69:291–299.
IARC 1995. Dry Cleaning, Some Chlorinated Solvents and Other Industrial Chemicals. IARC Monogr Eval Carcinoge Risk Hum 63.
Ingvordsen C. 1975. En Lille Beretning om Tøjrensning Gennem de Sidste 150 år [in Danish]. Copenhagen:Teknologisk Institut.
International Labour Office. 1981. International Standard Classification of Occupations. Revised ed. Geneva: International Labour Organisation.
Johansen K, Tinnerberg H, Lynge E. 2005. Use of history science methods in exposure assessment for occupational health studies. Occup Environ Med 62:434–441.
Kogevinas M, 't Mannetje A, Cordier S, Ranft U, Gonzalez CA, Vineis P, et al. 2003. Occupation and bladder cancer among men in Western Europe. Cancer Causes Control 14:907–914.
Kyyronen P, Taskinen H, Lindbohm ML, Hemminki K, Heinonen OP. 1989. Spontaneous abortions and congenital malformations among women exposed to tetrachloroethylene in dry cleaning. J Epidemiol Com Health 43:346–351.
Lynge E, Carstensen B, Andersen O. 1995. Primary liver cancer and renal cell carcinoma in laundry and dry-cleaning workers in Denmark. Scand J Work Environ Health 21:293–295.
Mikkelsen AB, Petersen R, Rasmussen K, Sabroe S. 1983. Klorerede Opløsningsmidler—et Arbejdsmiljøproblem [in Danish]. Copenhagen:Fremad.
Ministry of Social Affairs and Health. 2005. HTP Values-2005. Handbooks of the Ministry of Social Affairs and Health. Helsinki:Ministry of Social Affairs and Health.
Mundt KA, Birk T, Burch MT. 2003. Critical review of the epidemiological literature on occupational exposure to perchloroethylene and cancer. Int Arch Occup Environ Health 76:473–491.
Muños N, Day NE. 1996. Esophageal cancer. In: Cancer Epidemiology and Prevention (Schottenfeld D, Fraumeni JF Jr, eds). 2nd ed. New York:Oxford University Press, 681–706.
OSHA. 2005. Reducing Worker Exposure to Perchloroethylene (PERC) in Dry Cleaning. Washington, DC:Occupational Safety and Health Administration. Available: http://www.osha.gov/dsg/guidance/perc.pdf [accessed 20 December 2005].
Percy C, van Holten V, Muir C. 1990. International Classification of Diseases for Oncology. 2nd ed. Geneva:World Health Organisation.
Pukkala E, Söderman B, Okeanov A, Storm H, Rahu M, Hakulinen T, et al. 2001. Cancer Atlas of Northern Europe. Helsinki:Cancer Society of Finland.
R Development Core Team. 2004. R: A Language and Environment for Statistical Computing. Vienna:R Foundation for Statistical Computing. Available: http://www.R-project.org [accessed 1 June 2005].
Ruder AM, Ward EM, Brown DP. 2001. Mortality in dry-cleaning workers: an update. Am J Ind Med 39:121–132.
Schleisner J. 1967. Er de Konventionelle Renseriers Maskinpark Tidsvarende? [in Danish]. Nordisk Tidsskrift for Rensning, Favning og Vask 79(May):8–9.
Siemiatycki J, ed. 1991. Risk Factors for Cancer in the Workplace. Boca Raton, FL:CRC Press.
Silverman DT, Levin LI, Hoover RN. 1989a. Occupational risks of bladder cancer in the United States: II. Nonwhite men. J Natl Cancer Inst 81:1480–1483.
Silverman DT, Levin LI, Hoover RN. 1990. Occupational risks of bladder cancer in white women in the United States. Am J Epidemiol 132:453–461.
Silverman DT, Levin LI, Hoover RN, Hartge P. 1989b. Occupational risks of bladder cancer in the United States: I. White men. J Natl Cancer Inst 81:1472–1480.
Smith EM, Miller ER, Woolson RF, Brown CK. 1985. Bladder cancer risk among laundry workers, dry cleaners, and others in chemically-related occupations. J Occup Med 27:295–297.
Statistical Office of the United Nations. 1958. International Standard Industrial Classification. Statistical Papers, Ser M, No. 4, Rev. 1. New York:United Nations.
Statistisk Sentralbyrå. 2000a. Manufacturing Statistics 1999 [in Norwegian]. Oslo:Statistisk Sentralbyrå.
Statistisk Sentralbyrå. 2000b. External trade 1999 [in Norwegian]. Oslo:Statistisk Sentralbyrå.
Statistisk Sentralbyrå 2000c. Statistics of the Norwegian Population. Available: http://www.ssb.no/emner/historisk_statistikk/aarbok/ht-020210-049.html [accessed 3 June 2003].
Statistiska Centralbyrån. 1995a. Manufacturing Statistics [in Swedish]. Stockholm:Statistiska Centralbyrån.
Statistiska Centralbyrån. 1995b. External Trade [in Swedish]. Stockholm:Statistiska Centralbyrån.
Statistiska Centralbyrån. 2000a. Statistics of the Swedish Production 1996–2000. Available http://www.ssd.scb.se/databaser/makro/start.asp [accessed 3 June 2003].
Statistiska Centralbyrån. 2000b. Statistics of the Swedish Foreign Trade 1996–2000. Available: http://www.ssd.scb.se/databaser/makro/start.asp [accessed 3 June 2003].
Statistiska Centralbyrån. 2000c. Statistics of the Swedish Population. Available: http://www.ssd.scb.se/databaser/makro/start.asp [accessed 3 June 2005].
Swedish National Board of Occupational Safety and Health. 1997. Occupational Exposure Limit Values. Stockholm:Swedish National Board of Occupational Safety and Health.
Therneau T, Lumley T. 2004. Survival: Survival Analysis, Including Penalised Likelihood. R package version 2.16. Available: http://www.R-project.org [accessed 1 June 2005].
Tilastokeskus. 2000a. Manufacturing Statistics 1999 [in Finnish]. Helsinki:Tilastokeskus.
Tilastokeskus. 2000b. External Trade. [in Finnish]. Helsinki: Tilastokeskus.
Tilastokeskus. 2000c. Statistical Yearbook of Finland 2000. Helsinki:Tilastokeskus.
Vaughan TL, Stewart PA, Davis S, Thomas DB. 1997. Work in dry cleaning and the incidence of cancer of the oral cavity, larynx, and oesophagus. Occup Environ Med 54:692–695.
WHO. 1965. International Classification of Diseases. Version 8. Geneva:World Health Organization.

OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY
AIR TOXICS PROGRAM
AIR TOXICS SCIENCE ADVISORY COMMITTEE

MEETING #17
May 18, 2006 ~ Meeting Summary

Committee Administration
Members Attending: Bill Lambert, Natalia Kreitzer, Candee Hatch, Kent Norville, Brian Patterson. DEQ Staff: Bruce Hope and Svetlana Lazarev.

The Committee accepted the notes from their May 8, 2006 meeting with a few minor corrections.

Bill welcomed Dr. Dean Atkinson (associate professor of chemistry at PSU) to the meeting as a guest. He will be replacing Dr. Staci Simonich in June if his appointment is approved by the Director and concurred with by the Environmental Quality Commission. In June the Committee will return to the discussion of implementation guidance. Bill thanked Dean for volunteering to serve.

Process for Establishing / Revising Benchmarks
In February, Bruce had prepared, and the Committee had reviewed, a memorandum outlining a 6-step process for identifying air toxics which might require benchmarks. This memorandum was revised, based on comments made at the May 8th ATSAC meeting, to include a process for revising existing benchmarks. Although, by rule, benchmarks need to be reviewed every 5 years, the point was raised that it would be good if, once benchmarks are either established or revised, they be usable as quickly as possible. Bruce shared the memorandum with Paul Logan at the Oregon Department of Justice to see if there were ways to expedite using new or revised benchmarks. Paul's answer was that benchmarks cannot be used until they go through rulemaking (including a public comment / hearing opportunity) and become administrative rules. Bill suggested that we explore the possibility of using an ATSAC meeting, with appropriate public notices, a comment period, and a hearings officer, as a vehicle for expediting the rulemaking process. Bruce will explore this possibility with Paul Logan. Some changes were suggested to the present draft of the memorandum (*Bruce made these changes and sent a revised version to Committee members shortly after the meeting*).

Arsenic
The benchmark for arsenic was reviewed in response to a comment received during the public comment period. It was suggested that the ATSAC use the 1997 USEPA IRIS URE of 4.3×10^{-3} $(\mu g\ m^{-3})^{-1}$ to calculate a benchmark for elemental arsenic, rather than the California OEHHA URE of 3.3×10^{-3} $(\mu g\ m^{-3})^{-1}$ which is older (1990). Both result in a similar benchmark concentration of 0.0002 - 0.0003 $\mu g\ m^{-3}$. After a short discussion, it was the consensus of the Committee to base the benchmark for elemental arsenic on the USEPA IRIS URE to yield an ABC of 0.0002 $\mu g\ m^{-3}$ because of the preference for using IRIS data and because the evaluation was more recent.

Cadmium
The benchmark for cadmium was reviewed in response to comments received during the public comment period. Several comments were received from the International Cadmium

Association. One suggested that the presently recommended benchmark of 0.0006 $\mu g\ m^{-3}$ is lower than a typical background value. Another comment assumed incorrectly that Oregon's acceptable cancer risk is 1:100,000 while it is, by rule, actually 1:1,000,000. Another comment was concerned about our use of old (1980) toxicological information as the basis for the benchmark and that the ATSAC should wait for the results from new studies. Despite these comments, DEQ recommended no change in the proposed benchmark. During its discussion of this air toxic, the Committee clarified that "cadmium" includes cadmium and cadmium fumes and that the benchmark was based on the 1998 USEPA IRIS URE of 1.8×10^{-3} $\mu g\ m^{-3}$. Bill noted that the International Cadmium Association had submitted no new information in support of a different benchmark nor was there any such information known to Committee members. He therefore recommended that the proposed benchmark remain unchanged. The Committee agreed to this unanimously and the 0.0006 $\mu g\ m^{-3}$ benchmark was retained.

Nickel

The benchmark for nickel was reviewed in response to a comment received during the public comment period. The Nickel Producers Environmental Research Association had suggested that it be made clearer which form of nickel the benchmark was for and that the ATSAC consider an alternative value for "nickel and nickel compounds." The Association submitted additional technical information in support of their comments and suggestions. The presently proposed benchmark actually applies only to nickel refinery dust and not to a variety of nickel compounds. Bill noted that the comments from Wilmer Hill and the Producers Association were helpful in making the Committee think of nickel in a different way.

Candee noted that nickel refinery dust comes only from the refining process, whereas other nickel emissions are mainly from fuel combustion. She suggested retaining the benchmark for nickel refinery dust and adding a separate benchmark for nickel and soluble salts. Brian was concerned that the Committee might simply be subdividing nickel compounds and not adding anything new in response to the substantial evidence that the majority of nickel emissions, other than refinery dust, are the subsulfide, oxide, or soluble salts. The comment from the Producers Association suggested a speciation of nickel emissions into several (assumed) categories and adjustments on this basis to reduce the benchmark for "nickel and nickel compounds" to 0.03 $\mu g\ m^{-3}$, something more representative of a mixture. Brian indicated that he wouldn't choose to go this route and proposed an alternative with two categories: (a) carcinogenic: refinery dust, nickel sulfates, and nickel oxides with a benchmark of 0.004 $\mu g\ m^{-3}$ and (b) non-carcinogenic: nickel metal and soluble salts with a benchmark of 0.05 $\mu g\ m^{-3}$. Candice agreed with Brian on not using the Producers suggested speciation methodology. It was then mentioned that California has additional categories for subsulfide and soluble Ni compounds. Brian then suggested combining nickel oxide with nickel refinery dust. Candee was not comfortable combining nickel oxides with refinery dust, as we cannot be sure what is coming out of combustion sources.

Kent asked how, from the monitoring point of view, do you distinguish between the different species of nickel? In short, the monitoring methods currently used by DEQ do not differentiate between the different forms of nickel. Candee noted that some information will have to be placed in guidance to make sure we know what is being measured.

Bill ultimately proposed three categories: (a) nickel refinery dust with a benchmark of 0.004 $\mu g\ m^{-3}$ calculated with the USEPA IRIS URE, (b) nickel subsulfide with a benchmark of 0.002 $\mu g\ m^{-3}$ calculated with the USEPA IRIS URE, (c) seven soluble nickel compounds with a benchmark of 0.05 $\mu g\ m^{-3}$, which is the OEHHA REL. It was decided that nickel oxides will be addressed in the guidance. These proposals were accepted by the Committee.

Tetrachloroethylene (PERC)
Bill opened the discussion by noting that several comments (from the Oregon Dry Cleaners Association, the National Drycleaners Association, and the Halogenated Solvents Industry Association) requested that the ATSAC reconsider the classification and treatment of PERC as carcinogen. All three organizations submitted substantial peer-reviewed literature in support of their request (this information was not available in early 2005 when the ATSAC first discussed this air toxic). As a result, the Department recommended that the ATSAC review PERC's designation and consider the possible use of the non-cancer reference concentration. Part of the new information is the fact that both Health Canada and the Ontario Ministry of the Environment no longer regulated PERC using a human cancer endpoint because it appears to be a very weak carcinogen in humans. While studies in rats showed increased levels of liver cancer, such evidence is not consistent in human studies. Bill said that this is a fundamental point and compelling new information. It is very unclear if PERC is a carcinogen in humans, and if it is a human carcinogen, its potency is very weak.

At Brian's request, Bill described some of the weaknesses and issues in the epidemiological studies that have tried to link human cancer occurrences to exposure to PERC. Confidence in findings is limited by low number of observations, and controlling for potential confounding factors is difficult. Often smoking and alcohol consumption are factors that have not been separated from the factor of working as a dry cleaner. The Mundt et al. 2002 review paper presents the range of risk estimates from available cohort and case-control studies of liver, lung and bladder cancers. Considerable heterogeneity has been observed in risk estimates. A new case-control study (Lynge et al. 2006) of Scandanavians employed in the dry cleaning industry in the 1970s controlled for exposure to smoking and alcohol, and failed to demonstrate increased risks of cancer of the gastric cardia, pancreas, liver, or with non-Hodgkin's lymphoma. The evidence for PERC's non-cancer effects is much stronger. The Committee decided to revise PERC's benchmark to reflect its non-cancer effects. This decision raised the previously proposed benchmark from 0.02 $\mu g\ m^{-3}$ to 35 $\mu g\ m^{-3}$, which is the 1991 OEHHA REL.

Review of Comment and Discussion Summaries for Rule Package
Bill indicated that Attachments B and C of the final rulemaking package need to be reviewed by the Committee to be sure they clearly express the rationale and choices the ATSAC made and to make sure each Committee member is comfortable with the language. Bruce needs any comments of corrections no later than Thursday, May 25th in order to stay on schedule.

Public Comments
None.

Next Meeting
June 15, 2006
DEQ Headquarters Office, 3A
811 S.W. Sixth Avenue
Portland

Connie Brower
DENR/Division of Water Quality Planning Section
1617 Mail Service Center
Raleigh, NC 27699-1617

July 21, 2006

Dear Ms. Brower,

I would like to comment on the proposed rule changes as proposed in 15A NCAC 02B. 0208, STANDARDS FOR TOXIC SUBSTANCES AND TEMPERATURE.

The proposal in Section (2) (i) raises the Fish Consumption rate from 6.5 gm/day to 17.5 gm/day. This increase gives the result of lower numerical limits on Surface Water Quality Standards.

If true, that means a 270% increase in consumption of North Carolina fish and shellfish. I am not sure that increase is justified. I do believe that our diets include more seafood. However, are we eating more freshwater seafood grown in North Carolina?

I, personally, consume much more seafood now. Approximately 95% of the seafood I do eat is at home from purchases made at grocery stores. I surveyed my refrigerator/ freezer and had the following inventory:

8 lbs of shrimp from Texas
3 lbs of salmon from Washington
2 lbs of tuna from the Philippines
0 lbs of seafood from North Carolina

This raises the question: Is there justification for a 270% increase in FCR to calculate water quality standards for North Carolina surface waters if the seafood is from out of state?

I have tried to find out the actual North Carolina freshwater fish consumption on the internet but I can only find advisories such as Mercury and PCBs. With much of the state on a mercury advisory (the entire area south and east of I-85), it seems to me that a reduction of the 6.5 gm/day maybe justified in lieu of an increase.

Sincerely,

David W. Lawson,
ORC, City of Graham

Attachment A-11

CHRONIC
CADMIUM AMBIENT WATER QUALITY CRITERIA
CALCULATION
USING THE 2004 CHADWICK ECOLOGICAL CONSULTANT RECALCULATION DOCUMENT

Chronic Slope (m_C)	**Hardness**	**FCV (ug/L) (4 most sensitive species; # =16)**	**Final Chronic Intercept (b_C)**
0.7998	50	0.26813	-4.4451

CCC (dissolved) ; ug/L=	0.2515
CCC (total) ; ug/L=	0.2681
CCC (total) ; mg/L=	2.681E-04
mC =	0.7998
bC=	-4.4451
Hardness=	50
CCC CF=	0.938

Calculations per App. B in EPA's National Recommended WQ Criteria (Nov. 2002: EPA-822-R-02-047.)

Hardness-dependant metals' criteria may be calculated from the following:
CCC (Total) = exp{mC [ln(hardness)]+ bC}

Attachment A-12

Survey of PQL's Used by Certified NC Labs and USFWS

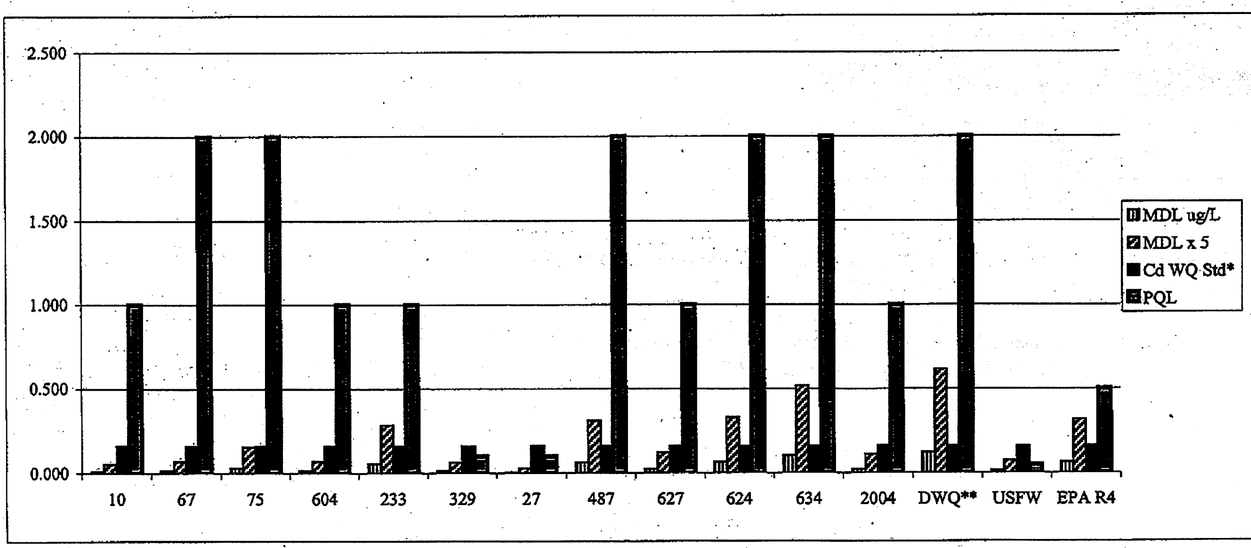
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Lab ID	**10**	**67**	**75**	**604**	**233**	**329**	**27**	**487**	**627**	**624**	**634**	**2004**	**DWQ****	**USFW**	**EPA R4**
MDL ug/L	0.011	0.014	0.031	0.014	0.057	0.013	0.006	0.062	0.024	0.066	0.103	0.022	0.123	0.01475	0.0635
MDL x 5	0.054	0.070	0.155	0.070	0.285	0.065	0.029	0.311	0.120	0.331	0.516	0.110	0.615	0.074	0.318
Cd WQ Std*	0.160	0.160	0.160	0.160	0.160	0.160	0.160	0.160	0.160	0.160	0.160	0.160	0.160	0.160	0.160
PQL	1.000	2.000	2.000	1.000	1.000	0.100	0.100	2.000	1.000	2.000	2.000	1.000	2.000	0.048675	0.50

Cd Std* - Proposed standard of 0.16 ug/L Cd.

DWQ -** The MDL standard used was 0.50 ug/L Cd and was taken through the entire sample preparation step. EPA Method 200.2 was used to prepare the sample.DWQ received ATP approval to use EPA Method 200.8 in Nov. 2000. The MDL submitted was 0.150 ug/L. The DWQ Lab is in the process of changing the Cd PQL to 1.0 ug/L.

USFW Average of 4 MDL's reported by USFW Laboratories. They calculated PQL (MQL) as 3.3 * MDL.

PQL - Practical Quantitation Limit (PQL) - The PQL is about 5 times the MDL and represents a practical and routinely achievable detection level with a relatively good certainty that any reported value is reliable. ***(Standard Methods, 20th Edition)***.



ATTACHMENT A-13

Detailed Tracking Report for IRIS Chemical Assessment

Methyl tert-butyl ether (MTBE) **Assessment Start Date: 12/10/1998** **Assessment End Date: TBD**

Tracking Report Last Updated: **05/11/2006**

Lead Offices: NCEA-W

EXPECTED/ACTUAL DATES OF ACTIVITIES AND EVENTS

Activity/Event	Expected Start Date	Expected Completion Date	Actual Completion Date
1. Literature Search:			
2. First Draft:			
3. Second Draft:			
4. Internal Peer Consultation:			
5. Agency Review:	06/17/2005	03/28/2007 (*)	
6. External Peer Review and Public Availability:	04/01/2007	10/01/2007	
7. Final Draft:	10/01/2007	05/01/2008	
8. Final ORD/NCEA Approval:	05/01/2008	08/01/2008	
9. Final Edit:	08/01/2008	09/01/2008	
10. Web Posting:	09/01/2008	09/30/2008	

This page was generated on Wednesday, January 31, 2007

View the graphical version of this page at: http://cfpub.epa.gov/iristrac/index.cfm?fuseaction=viewChemical.showChemical&sw_id=1040

DIVISION OF WATER QUALITY
ENVIRONMENTAL SCIENCES SECTION
Biological Assessment Unit

September 14, 2006

MEMORANDUM

To: Jimmie Overton

Through: Trish F. MacPherson

From: Steven Beaty and Bryn H. Tracy SRB BHT

Subject: Review of Blue Ridge Paper Products Inc.'s Canton Mill – Balanced and Indigenous Species Study for the Pigeon River (Clean Water Act Section 316 (a) Demonstration) with Appendices including: Pigeon River Temperature Model and 2005 Biological Assessment, May 2006

Staff of the Biological Assessment Unit (BAU) have reviewed Blue Ridge Paper Products Inc.'s May 2006 document (BRPP 2006) and have independently conducted a biological assessment of the benthic communities of the Pigeon River in July 2006. This memorandum summarizes Staff's review of BRPP (2006) and the 2006 benthic assessment.

2005 Benthic Community Assessment by BRPP
Staff concluded that the 2005 assessment had numerous problems that warranted a response from BRPP and its consultant. Staff recommended that the problems were substantial enough that the data could not be compared to data collected in earlier years by DWQ, should not be used for use support determinations by the Division of Water Quality's (DWQ) Basinwide Planning Unit, and should not be used by DWQ's Modeling and TMDL Unit for de-listing a segment of the river from DWQ's 2006 Clean Water Act § 303 (d) list (BAU Memoranda B-20060511 and B-20060703).

2006 Benthic Community Assessment by DWQ
Because the 2005 BRPP data were not collected according to DWQ's standard operating procedures (NCDENR 2003; BAU Memoranda B-20060511 and B-20060703), BAU Staff conducted an independent assessment of the benthic communities in the Pigeon River in July 2006 (BAU Memorandum B-20060914). This study concluded:

1. Upstream of the mill at the NC 215 site (at the City of Canton park), the benthic community was rated Good. During the drought of 2002, the community at a site one quarter mile upstream was rated Good-Fair.
2. Two segments of the river downstream of the mill were rated as Fair and thus considered as impaired: at SR 1642 (in the Town of Clyde) and at a new site below the City of Waynesville's WWTP discharge (off SR 1519). The SR 1642 site was rated Poor in 2002.
3. At the most downstream site (at the Hepco bridge at SR 1338) the community had improved to Good-Fair. The community was also rated Good-Fair in 2002.

The study concluded that the mill continued to have an effect on that segment of the river downstream of the mill to the Town of Clyde. This reach of the river has no major NPDES permitted dischargers other than the mill. It was not possible to determine the individual or cumulative effects of the mill's discharge or the Town of Waynesville's WWTP discharge on the benthic community below the Town of Clyde at the site off SR 1519.

Temperature Model
BAU Staff were not qualified to comment on the Pigeon River Temperature Model (Appendix A of BRPP (2006)).

Balanced and Indigenous Species Study
The DWQ does not have a formal procedure for conducting a CWA § 316 (a) Demonstration, but DWQ Staff consulted with and approved the procedure adopted by Blue Ridge Paper Products, Inc. and its consultants prior to the study being conducted in 2005. Aside from some minor questions and typographic errors which were handled informally *via* e-mail and telephone calls between Staff and Mr. Paul Dickens (Manager, Environmental Affairs, BRPP), the report supports the Master Rationale that has been presented (BRPP 2006).

The fish community of the Pigeon River has been shaped by its biogeography, gradient, instream habitat, size of the river, historical and current anthropogenic point source impacts from industrial and municipal effluents, historical and current nonpoint source impacts from agriculture and landuse practices, and by hydrological modifications (i.e., Walters Dam). Under the existing thermal conditions specified in the current NPDES Permit and based upon a thorough assessment of the fish communities at 11 mainstem sites and three tributary sites, the Master Rationale (page 45) concluded:

1. By EPA definition of a Balanced and Indigenous Community, the fish community in the Pigeon River:
    a. Has diversity,
    b. Has the capacity to sustain itself through cyclical seasonal changes,
    c. Contains the necessary food chain species, and
    d. Is not dominated by pollution-tolerant species.
2. The CWA § 316 (a) guidelines for assessing Appreciable Harm due to the temperature were evaluated and determined that:
    a. There was no thermal blockage of migrations;
    b. Poor reproduction was not evident;
    c. There was no evidence of increased vulnerability to predation or disease;
    d. The fish community showed no failure to recover from stresses;
    e. There was no long-term avoidance of the warmed reaches;
    f. There was no simplification of the community due to loss of expected species; and
    g. The trophic structure of the fish community had not been simplified.
3. None of the 12 Representative and Important Species appeared to be excluded because of thermal sensitivity. Thermally tolerant species such as the Common Carp and the Redbreast Sunfish are either no longer abundant or declining in overall percent abundance. Species that are unable to recolonize the formally impacted reaches are being aided by a re-introduction program that is supported by BRPP, DWQ, the North Carolina Wildlife Resources Commission, and the Tennessee Department of Environment and Conservation.
4. The 2005 study concluded that there is a balanced community of fish in the river based upon six CWA § 316 (a) criteria:
    a. Threatened or endangered species are not an issue;
    b. There is no increase in the abundance of nuisance species;
    c. There is no decrease in abundance of expected species;
    d. There is no damage to critical aquatic organisms;
    e. There is no major changed in population composition that can be related solely to the thermal discharge; and
    f. There is no decrease in sport fisheries.

Staff's only disagreement with conclusions of the report are centered around the Redbreast Sunfish as a nuisance species and the interpretation of written statements regarding nuisance species made in a memorandum from Staff (Bryn H. Tracy) to Jimmie Overton and Forrest Westall, dated June 12, 2001. The Redbreast Sunfish is not native to the Pigeon River nor to any waterbodies in the Mississippi River drainage. It is a thermally tolerant, warmwater species, it may have contributed to the decline of the Longear Sunfish, a species native to the Pigeon River watershed, and it may be in competition with the native, intolerant Rock Bass. As such, it satisfies the definition of a nuisance species as set forth by EPA (page 77, May 01, 1977 and BRPP Report, Introduction, page 5). On a positive note, the abundance of the Redbreast Sunfish has declined from prior surveys and it did not dominate the community in 2005 as it had done in 2000. The study was conducted in 2005, a year after the devastating hurricane-induced flooding throughout the Pigeon River watershed. Staff will be especially interested in the recovery of the fish community if this study is conducted again in 2010.

If you have any questions regarding Staff's interpretation of the report, please do not hesitate to contact the authors of this memorandum.

References

BRPP. 2006. Canton Mill – Balanced and indigenous species study for the Pigeon River (Clean Water Act Section 316 (a) demonstration) with appendices including: Pigeon River temperature model and 2005 biological assessment, May 2006. Canton, NC. Prepared by University of Tennessee, Institute of Agriculture, Department of Forestry, Wildlife and Fisheries. J. Larry Wilson, PhD, Principal Investigator. Knoxville, TN.

NCDENR. 2003. Standard operating procedures for benthic macroinvertebrates. Biological Assessment Unit. North Carolina Department of Environment and Natural Resources. Division of Water Quality. Water Quality Section. Environmental Sciences Branch. Raleigh, NC.

pc: Sergei Chernikov (Western NPDES Program)
Roger Edwards (Asheville Regional Office, Surface Water Protection)
Matt Mathews (Point Source Branch)
Susan Wilson (Western NPDES Program)