

Water Quality Standards Advisory Committee (WQSAC)
Dissolved Oxygen (DO) Subcommittee

Meeting 3 Summary

Thursday, April 13, 2017 1:30 pm – 3:30 pm
NH Department of Environmental Services (NHDES)

Participants on DO Subcommittee

First Name	Last Name	Organization	Present
Jeff	Andrews	NHDES	✓
Bill	Arcieri	Vanasse, Hangen, Brustlin, Inc. (VHB)	
Clifton	Bell	Brown and Caldwell	✓ (phone)
Nate	Brown	Peterborough WWTF	
Gregg	Comstock	NHDES	✓
Sarita	Croce	Town of Merrimack	✓
David	Deen	Connecticut River Watershed Council	
Ted	Diers	NHDES	✓
Ken	Edwardson	NHDES	✓
John	Hall	Hall & Associates	✓ (phone)
Donna	Hanscom	NH Water Pollution Control Association	
Richard	Head	Rath, Young and Pignatelli, P.C.	
Mark	Hutchins	Normandeau Associates	
Don	Kretchner	DK Water Resource Consultants	✓
Ann	Lightbody		
John	Magee	NH Fish & Game Department	✓
Brian	Maloy	Monadnock Paper Mills	✓
Mike	Metcalf	NH Water Works Association	
Eileen	Miller	NH Association of Conservation Districts	✓
Allan	Palmer	Rivers Management Advisory Committee	
Dean	Peschel	Peschel Consulting	✓
Robert	Robinson	City of Manchester EPD	✓
Emily	Schmalzer	Lamprey River LAC	
Paul	Stacey	NH Fish and Game Department	✓
John	Storer	City of Rochester – Public Works	✓ (phone)
Jeanne	Voorhees	EPA Region I	✓
Matt	Wood	NHDES	✓
Sherry	Young	Rath, Young and Pignatalli	

Other Participants

First Name	Last Name	Organization	Present?
Ralph	Abele	EPA	✓ (phone)
Andy	Chapman	NHDES	✓
Sam	Demeritt	NH Wildlife Federation	✓
Jim	Hagy	EPA ORD	✓ (phone)
Dave	Neils	NHDES	✓
Ken	Rhodes	CLD	✓

Glen	Thursby	EPA ORD	✓ (phone)
Toby	Stover	EPA	✓
Mary Ann	Tilton	NHDES	✓
Ted	Walsh	NHDES	✓

Meeting Documents/Handouts

- **Today's Presentation and Agenda:** *20170413_DO Subcommittee Mtg Presentation.pdf*
- **Agenda Item 2: Acceptance of 2/19/17 Meeting Summary**
 - Draft Meeting Summary: *20170209_wqsac_DO_subcom_mtgsum_DRAFT.pdf*
 - Revised 2/9/17 presentation: *DO Subcommittee-meeting2 rev per 20170209_Mtg_comments.pdf*
- Agenda Item 5c. Freshwater Species/Life Stages/CWF Locations
 - Table: *20170413_DRAFT_FW_FishSpecies_LifeStage_FisheryType.pdf*
- **Agenda Item 6: A closer look at the 1986 EPA Freshwater DO Criteria**
 - *EPA Document: EPA_1986_440-5-86-003_Ambient_Water_Quality_Criteria_for_Dissolved_Oxygen.pdf*
- **Agenda Item 7: GBMC Submittal regarding Marine DO Criteria**
 - *Dr Diaz letter on NH DO Criteria 2-14-17.pdf*
 - *Memorandum - GBMC - DO Sat Articles.pdf*
 - *NHDES transmittal letter re Diaz.pdf*

Meeting Summary

- 1) **2/9/17 Meeting Summary** : There were no comments on the draft with the exception that the date should be changed from 2/9/16 to 2/9/17. The date of the draft meeting summary will be revised and the summary will then be marked as final.
- 2) **4/13/17 Powerpoint Presentation** :
 - a. Slide 2: Gregg Comstock reviewed the agenda.
 - b. Slide 4: Ted Diers reviewed the status of SB 127 (see slide for specifics). Ted also mentioned that the bill, if passed, would require use of a flow greater than the 7Q10 for determining nutrient permit limits for the protection of aquatic life and human health.
 - c. Slide 5: Jeanne Voorhees stated that EPA ORD personnel (Jim Hagy and Glen Thursby) are on the phone to participate in the discussions. Glen was the primary author of the 2000 EPA "Ambient Aquatic Life Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hatteras."

Gregg Comstock asked what the state would need to do to obtain EPA approval if NH were to adopt DO criteria that are less stringent than our current criteria but no less stringent than EPA's 1986 criteria. Jeanne thought that we would probably need to demonstrate that the newly adopted criteria are protective of the designated uses. She also stated that per the Endangered Species Act (ESA) EPA must consult with the fishery agencies (National Marine Fisheries Service (NMFS) and the US Fish and Wildlife Service) when new water quality standards are proposed to ensure that endangered species are protected.

John Hall stated that it was his understanding that a state would not have to demonstrate that designated uses are protected if they adopt criteria that are no less

stringent than EPA 304(a) criteria (i.e., for aquatic life protection, EPA's 304(a) criteria for DO includes the 1986 EPA Freshwater DO criteria document and the EPA's 2000 Aquatic Life Criteria for DO (Saltwater) Cape Cod to Cape Hatteras). John requested that EPA provide a document supporting Jeanne's position by next meeting. **Jeanne will consult with others at EPA and report back to the Subcommittee.**

- d. Slides 6 – 16: Follow Up on Action Items from Previous Meetings
 - i. Slides 7-12: Ken Edwardson presented results of analyses that he performed on the frequency of dissolved oxygen (DO) measurements in NH rivers and lakes versus temperature. The data generally shows that for a given percentile of measurements and category (i.e., $DO < 5 \text{ mg/L}$ or $DO \geq 5 \text{ mg/L}$), sample temperatures were typically highest for warmwater fisheries followed by transitional and then coldwater fisheries. For a given percentile of measurements and fishery type (i.e., warmwater, transitional or coldwater), samples with $DO < 5 \text{ mg/L}$ typically occurred at higher temperatures than samples with $DO \geq 5 \text{ mg/L}$ with rivers (see slides 9 and 11) showing a larger difference than lakes (see slide 12). This suggests that temperature may be more important in rivers than in lakes with regards to when DO is $< 5 \text{ mg/L}$ vs $\geq 5 \text{ mg/L}$.
 - ii. Slides 13-15: John Magee (NHFG) and Dave Neils (NHDES) discussed freshwater fish species, life stage periods, fishery type and the location of coldwater fisheries. John reviewed his handout which included a draft table showing the common name and abbreviations for 59 freshwater fish species, the season(s) they typically spawn and when their larval periods typically occur as well as whether they are considered warm or coldwater fish (slide 13). His table also included approximate dates for each season but emphasized that these can vary and are draft. **John will consult with others at NHFG to refine the table (and dates) and report back to the Subcommittee.** Dave reviewed the fresh coldwater fishery map he created in 2007 based on a logistic regression model which predicts the likelihood of brook trout and slimy sculpin presence based on latitude, elevation and drainage area. The model is estimated to be approximately 85% accurate. **In the future NHDES and NHFG plan to update the map by adding field data collected by NHFG (~ 4900 sites inspected for coldwater fish presence) and displaying the coldwater fisheries by assessment unit.** Once developed, the map can be used to determine where coldwater fishery DO criteria should apply.

Clifton Bell asked if the life stage periods could be broken out by month instead of season. John Magee replied "not really" since the periods change from year to year due to changes in water temperature and snow pack.

Clifton Bell asked if there is an operational definition of each life stage period based on water temperature. John Magee replied that they currently don't have a definition but it may be possible to refine the life stage dates based on an analysis of datalogger temperature data. Paul Stacey suggested

a probability distribution analysis that shows when the critical temperatures for each life stage typically occur. A margin of safety could then be added to make sure excursions are relatively infrequent (and the life stages are adequately protected). **John will discuss this with others at NHFG and report back to the Subcommittee.**

Paul Stacey noted that aquatic life includes more than just fish and asked if there has been any thought about including other species such as macroinvertebrates. Dave Neils replied that NHDES has macroinvertebrate biological indicators (IBIs) based on geographic location that is used to assess aquatic life but that at most macroinvertebrate sampling sites there isn't much DO data. More data would be needed to develop DO criteria for macroinvertebrates using NH data.

Jeff Andrews asked if we should consider developing DO criteria for transitional (or coolwater) species. Gregg replied that we should discuss criteria for coolwater fish and that some states apply cold water DO criteria (which are typically more stringent than warmwater DO criteria) to coolwater fish species. This is discussed in slide 19. **Gregg will discuss DO criteria for coolwater fish with others at NHDES and NHFG and report back to the Subcommittee.**

- e. Slides 16-44: Gregg led the discussion on the 1986 EPA Freshwater DO Criteria
 - i. Gregg noted that page numbers shown in the text of some of the slides indicate the page in the 1986 criteria document where that information is from.
 - ii. Slides 17-18 show the EPA recommended freshwater DO criteria and accompanying notes.
 - iii. Slides 19 includes some general observations about the criteria. For example they include criteria for early life stages (ELS) and other life stages (OLS) for cold water (CW) and warm water (WW) fisheries; that ELS have more stringent DO criteria because they are more sensitive and that CW criteria are intended to apply to certain coolwater fish as well as smallmouth bass.
 - iv. Slide 20 explains that the criteria include instantaneous minima, 7 day average and 30 day average DO criteria. The 7 day and 30 day average criteria are intended to limit the duration that the aquatic life is exposed to the instantaneous 1 day minima.
 - v. Slide 21 shows that it's possible that the EPA criteria could allow many (possibly 4 or 5) consecutive days of DO at the 1 day instantaneous minimum and still meet the 7-day mean minimum criteria. Is this protective?
 - vi. Slide 22 and 23 discuss how EPA intends the 7 day and 30 day means to be calculated. In general, calculations to determine compliance with the mean criteria do not use concentrations corresponding with supersaturated conditions. Where supersaturated conditions exist, the maximum DO concentration used in the calculations is the concentration corresponding to

100% saturation for that sample. This adds another step for determining compliance.

Ted Diers asked if DO measurements must be taken each day to determine compliance with the 7 day mean and 30 day mean criteria? Ken and Gregg replied that it would be preferable to have datalogger data, which can automatically collect data at specified intervals (such as every 15 minutes) each day. However, it may be possible, after analyzing datalogger data, to develop criteria based on grab samples that could be used for determining compliance. This has been done for determining compliance with NH's 75% average daily DO criteria for lakes and streams. Protocols are included in the Consolidated Assessment and Listing Methodology (CALM). Paul Stacey stated that it would be more robust and fair to stakeholders to use DO measurements from dataloggers for determining compliance vs grab samples.

- vii. Slide 24 compares NH's 75% average daily criterion (expressed as concentration for the various temperatures) to the EPA mean WW DO criteria vs temperature. Since percent saturation varies with temperature, NH's 75% average daily criterion (expressed as a concentration) varies with temperature whereas EPA's mean WW DO criteria do not. The graph shows that NH's average daily criterion are more stringent than EPA's mean WW DO criteria below temperatures of approximately 25°C and less stringent above approximately 25°C.
- viii. Slide 26 indicates that impacts of low DO on aquatic life (such as reductions in growth rate) are more severe at high temperatures because it increases the sensitivity of organisms to disease and toxic pollutants and that EPA's criteria are intended to be protective of such conditions.
- ix. Slides 27-35 discuss the level of production impairment (based on growth studies and information on temperature, disease and pollutant stresses) corresponding to 1986 EPA DO criteria, NH's DO criteria and PA's DO criteria.

Slide 27 indicates that the level of impairments assigned to the various DO criteria and life stages are subjective.

Slide 28 shows the level of production impairment for each fishery type and life stage. John Hall stated that there are safety factors built in to the way results of acute and chronic tests are translated into criteria. He thought the acute safety factor was greater than the chronic safety factor. **NHDES will contact EPA regarding the safety factors used to develop ambient water quality criteria.**

Slide 29 indicates that EPA selected mean DO criteria that are 0.5 mg/L higher than the "slight" production impairment (i.e., between 0 and 10% production impairment). However, for the 1 day instantaneous values they selected minima that range from the limit to avoid acute mortality (50%

production impairment) to “moderate” (20% production impairment). Is it appropriate to specify levels that are on the threshold of mortality? As indicated in slide 21, it’s possible such minima could last for 4 or 5 consecutive days. Is this protective?

Slide 30 indicates that EPA recommends more stringent criterion where there are manipulatable discharges that could cause repeated weekly cycles of minimum acutely acceptable DO. In such cases EPA recommends that the occurrence of daily minima below the 7 day mean minima should be limited to 3 weeks or the one day minima for CW and WW fish should be increased to 4.5 mg/L and 3.5 mg/L respectively. John Hall stated that it was his understanding that the manipulative discharge criteria were meant to apply to states that allow flow-based NPDES permits. That is, as the river flow increases, permits are written to allow the pollutant load from the WWTF to also increase. Consequently, DO in the stream can be depressed for significant periods, which could adversely impact aquatic life. He said such flow-based NPDES permits are not allowed in NH.

Slide 31 includes language from the 1986 EPA DO criteria document that states the criteria do not assure no-effects on production especially when criteria are just being maintained for considerable periods and that if a slight or moderate level of production impairment is unacceptable, then continuous exposures should use the no production impairment as means and slight production impairment values as minima.

Slides 32-35 show a comparison of the 1986 EPA criteria, NH’s criteria and PA’s criteria. The EPA criteria and level of production impairment are shown as a range based on the criteria in slides 17 and 31. PA selected instantaneous minima of 5 mg/L for all life stages and fishery types (i.e., production impairment ranging from moderate to slight) and 7 day mean criteria ranging from slight to between no and slight production impairment. Also worth noting is that PA’s criteria do not include a 7 day mean minimum or a 30 day mean criterion as recommended by the 1986 EPA document.

- x. Slides 36-44 include other factors that should be considered before deciding if EPA’s 1986 Freshwater DO criteria should be adopted in NH. Examples are provided below.

The EPA criteria are primarily based on laboratory studies (slide 36) which may not be representative of natural conditions. For example laboratory studies typically 1) preclude environmental stresses that may occur in nature, 2) do not give organisms time to acclimate to low DO, 3) include abundant food which saves the fish from having to expend energy hunting for food (which can stress the fish and make them more prone to disease), and 4) are conducted at a constant DO whereas in nature DO typically varies.

According to the 1986 EPA criteria document, variability in test conditions makes it very difficult to interpret data for DO effects (slide 37).

Ken Edwardson discussed how nitrogen sparging in lab studies to control DO removes carbon dioxide and artificially increases pH (slides 37-40) in the test waters that the fish are exposed. Studies have shown that organisms are more sensitive to low DO at low pH (see slide 40). This is another example of how lab results can differ from what occurs in nature and why it can be challenging to translate laboratory results to criteria that are protective of aquatic life under natural conditions.

Clifton Bell stated that exposure periods (i.e., the time that organisms are exposed to a certain DO concentration), also differ between lab and natural conditions.

John Hall said criteria should consider the assumptions used to develop NPDES permit effluent limits. For example, NPDES permits in NH are calculated based on the 7Q10 low flow which occurs, on average, once every 10 years. Are the safety factors used to develop and implement the criteria too conservative? In response, surface water quality criteria must be protective of the designated uses. How effluent limits in NPDES permits are developed is a separate issue.

Other factors to consider before deciding to adopt the 1986 EPA DO criteria include the fact that most of the research at the time was on salmonids. Relatively little research had been conducted on nonsalmonids and invertebrates (slide 41). Further, according to the 1986 EPA DO document there was relatively “sparse data” to determine the acute effects of low DO on nonsalmonids (slide 41). In addition, with regards to invertebrates the 1986 EPA document states that there was little information available regarding the effects of DO on invertebrates (slide 42). EPA assumed that if fish are protected, invertebrates will also be protected (although there may be a shift to more pollution tolerant species since acute lethal DO concentrations appear to be higher for many aquatic insects compared to fish) (slide 42). Is this an appropriate assumption? Finally, according the EPA document, information on the effect of DO fluctuations (which can occur under natural conditions) is “sketchy” (slide 43).

With regards to implementation of the 1986 EPA DO criteria, slide 44 indicates that we need to consider whether it’s realistic to assume we can collect sufficient data to determine compliance with the 7 day mean and 30 day mean criteria. Another potential issue is the fact that in order to compute compliance of the 7 day and 30 day means in accordance with the 1986 EPA document, we would need have temperature data and make sure compliance calculations use concentrations equal to 100% saturation for the maximum day concentration instead of concentrations associated with

supersaturated conditions. This adds another step for determining compliance and complicates automating the process.

In summary, in 1986, EPA did the best with what they had at the time. However, the above raises questions about the 1986 criteria (which are based on data that is over 30 years old) and if they are adequate to protect aquatic life (slide 43). **NHDES and NHFG will continue efforts to finish the freshwater species/life stage/ fishery table and the coldwater fisheries map. NHDES will continue to research and develop draft freshwater DO criteria for review by the Subcommittee.**

3) Next Steps

- a. Attendees will report back on the items in **bold text** above.
- b. Gregg will prepare a draft meeting summary for review.
- c. It was agreed the next meeting will focus on marine DO criteria and hopefully include a discussion/presentation by Dr. Diaz who was involved with development of the Chesapeake Bay DO criteria. At subsequent meetings we hope to have Glen Thursby of EPA discuss the approach used to develop DO criteria from Cape Cod to Cape Hatteras and Paul Stacey (formerly of CT DEEP) to discuss CTDEEP's DO criteria in Long Island Sound (which was based on the Cape Cod/Cape Hatteras approach).

4) Adjourn

- a. The meeting ended at approximately 3:30 pm.