Memorandum

To: April Talon, PE
Durham Town Engineer

Date: February 8, 2021

Project #: 52633.00

From: Peter J. Walker, VHB

Re: Oyster River Dam at Mill Pond - Feasibility Study
Town Council Questions

Our team's responses to the questions and comments posed by the Town Council are provided below.

Question/Comment from Dinny Waters on Monday, January 11, 2021: *On page 7 of the VHB report the last sentence in the next to last paragraph requires clarification. May be an opinion, not finite answer one of a meeting (I think Jamie Houle) had knowledge of the River and the Bay.*

Response: We believe this question relates to the following statement on Page ES-7 of the report's Executive Summary: *"Eliminating or reducing this biomass production would diminish the dissolved oxygen and nitrogen fluctuations produced under existing conditions."* Based on the water quality analysis provided in Section 3.5 of the Feasibility Study, we are confident that Dam Removal would reduce the amount of algae and aquatic plant biomass generated on an annual basis compared to the existing impoundment, and that this would accordingly reduce or eliminate the water quality issues within the impoundment.

Question/Comment from Jim Lawson on Monday January 11, 2021: *Do you know if there has ever been evidence of cyanobacteria (blue green algae) in the Mill Pond? I suspect there has based on its prevalence in other waterbodies in the seacoast.*

Response: Excessive algal and aquatic plant growth was reported in Mill Pond by Don Kretchmer in his 2014 *"Durham Ponds Assessment and Plan."* While our study did not specifically investigate whether or not cyanobacteria currently exist within Mill Pond, Dr. Wil Wollheim, Co-Director of the UNH Water Systems Analysis Group and a member of the VHB Team that developed the Feasibility Study, notes that his laboratory has evidence of Nitrogen fixation in the pond (through N2:Ar measurements). Since cyanobacteria are the main type of nitrogen fixers in ponds, especially if there is enough phosphorus, this provides indirect evidence for their presence. Further information on cyanobacteria are provided below in response to Councilor Lawson's comments dated February 2.

Question/Comment from Dinny Waters on Monday, January 12, 2021: *Dennis quoted data coming from page 51 of the VHB about the quantity of sediment …The report that I have does not have 51 pages?*

Response: Mr. Meadows was referring to Table 3.2-20 of the main body of the Feasibility Study which is posted on the Town's website. (Only the Executive Summary was included in the Council information package.)

Question from Wayne Burton on Friday, January 15, 2021: *The Agricultural Commission decided last night not to take a position on the future of the dam. But I informally spoke with two members later who expressed a concern of many, the fate of the toxins currently in the impoundment. Under removal, they are concerned about spreading the toxins down the river. Under reinforcement, they are concerned about increasing the concentration of toxins in place. As I recall this issue is partly addressed somewhere in the reports. It appears support for #3 but without dredging to reduce the cost below removal is a strategy of some. But that begs the question of the efficacy of sequestering toxins in the impoundment. Resolution of this issue could go a long way toward advancing the dialogue.*

2 Bedford Farms Drive
Suite 200
Bedford, NH 03110-6532
P 603.391.3900

Response: The Feasibility Study reported data related to the presence of polycyclic aromatic hydrocarbons (PAHs) and metals in submerged sediments within, above and below Mill Pond. We understand this finding has created concern within the community. To help clarify this issue, we offer the following:

- Two sets of screening criteria are discussed in the Study. The first relates to ecological risk; these criteria are based on toxicity to aquatic organisms that would reside within the water column and/or sediments themselves. These screening criteria are intended to be broadly applicable (*i.e.,* to a wide range of environments and organisms), are intentionally biased in the direction of overestimating risk, and therefore are quite conservative. The second set of screening criteria relate to the state "S-1 Standards" which are applicable to human health. Generally, the ecological screening thresholds are much lower than the S-1 standards.

- PAHs and metals are commonly found in urban environments, and may be the result of anthropogenic or naturally occurring sources. Finding these chemicals at the levels observed during this study is not considered unusual; our team is familiar with similar studies of surficial and submerged sediments around the region, and other studies have returned similar results. Many studies have identified sources of PAHs in urban stormwater including runoff from asphalt paved surfaces and vehicle emissions; sometimes PAHs are indicative of our history of burning wood, coal, or oil to heat our homes or power our industry. Arsenic is commonly reported in the seacoast region and is likely the result of a naturally occurring background condition. Councilors and members of the public with private drinking water wells may very well be familiar with this issue as a significant source of arsenic in the southeastern New Hampshire is our famed granite bedrock.

- Human Health: Our study addressed the question of whether dam removal could expose sediments that would pose a risk to human health. As discussed in Section 3.3 of the Study, we found that such exposed sediments are unlikely to represent an additional or unacceptable risk to human health. We do recommend additional sampling of any dredged sediments under "Option 1 – Pond Restoration Dredge" or "Option 2 – Active Channel Restoration," but this recommendation is primarily to determine whether special handling or disposal measures would be required, and could become a condition of the NHDES permits required for either dam stabilization or removal. The cost of these studies and special handling is built into the costs for Option 1 and Option 2.

- Ecological Risk: Our study found that average PAH concentrations are slightly greater within and downgradient of Mill Pond, as compared to the upstream samples. There appears to be more variability in the spatial trends for target metals, with greater concentrations of mercury and chromium observed within Mill Pond and/or downstream of the dam, compared to those upstream. See Figures 3.3-1 and 3.3-2 for some information on the spatial distribution of PAHs and metals. *The fact that downstream sediment quality is similar to sediment within the impoundment suggests that transport of these sediments from upstream to downstream would not significantly impact the quality of downstream sediments.*

- Mitigation of Risk: Our study notes that if sediments are dredged from the impoundment under Option 1 or Option 2, those sediments should be sampled prior to reuse or disposal to ensure that they do not pose a risk to human health or groundwater. Our study does not suggest that the pond should be dredged to remediate the ecological risk if the dam remains in place. We do, however, believe that Option 2 - Active Channel Restoration is an appropriate means of managing the possible impact of downstream sediment transport – regardless of the sediment quality.

- Coordination with NHDES: The sediment sampling and risk assessment was conducted in accordance with the NHDES guidance on such studies. Our June 2020 Sediment Sampling and Analysis Plan was reviewed and approved by NHDES – it is included in the Feasibility Study as Appendix D. Following the 2020 sampling efforts, we submitted the results to NHDES who conducted a preliminary review. At a meeting this fall, NHDES indicated general support for an Active Channel Restoration strategy as an appropriate approach to manage issues related to sediment migration.

Questions from Katherine Marple on Friday, January 15, 2021:

KM1) *Is the distance from the Mill Pond Dam to the UNH impoundment enough to allow fish spawning?*

Response: At least 2.6 river miles of stream habitat would be restored to a free-flowing condition if the dam were to be removed, including approximately 1.8 river miles on the Oyster River mainstem, 0.4 mile of Hamel Brook and 0.4 mile of College Brook. This represents valuable spawning habitat for anadromous fish. In addition to obvious benefits to the river herring population, rainbow smelt *(Osmerus mordax)* habitat is expected to increase significantly. These fish typically spawn in riffle habitat near the interface of salt and freshwater and for a short distance upstream. The current presence of the dam significantly limits this habitat type.

KM2) *My sense is that much of the silt that exists in the Mill Pond will not flow down the river once the pond is gone. Only silt in the channel will move. Will the channel be dredged to remove alleged hazardous materials?*

Response: The sediment that is most likely to become mobilized under Alternative 5 would be from the submerged channel ("thalweg"). This channel is currently flooded by the dam, but is still visible in the bathymetric mapping and in aerial photos, and generally corresponds to the remaining open water area. Material in the outer portions of Mill Pond (the shallowest areas located close to Mill Pond Road and the emergent habitat on the south side of the pond) would be less likely to become mobile, but some movement of these sediments may occur during high river flows. The study team has recommended "Option 2 – Active Channel Restoration" as a means of ensuring a stable channel and minimizing the possible effects of downstream sediment transport. Please see our response to Councilor Burton's question above for a discussion of sediment quality.

KM3) *In the refurbishing of the pond floor, would new soil be introduced to allow for alternative vegetation (grasses, trees, that sort of thing)?*

Response: Regardless of the alternative selected, further detail on the project design would be developed and included in a final design plan set. If the dam were to be removed, it is expected that disturbed areas within the footprint of the dam and channel restoration would be restored using a variety of techniques including placement of loam and native seed, planting of native woody species, and placement of jute or coir erosion control fabrics to allow native vegetation to become established. These measures would provide habitat and control erosion. We do not, however, expect that new soil would be introduced into the dewatered pond bed. Our approach to the restoration would incorporate design concepts and lessons from other restoration projects around the seacoast, including the Wagon Hill living shoreline project.

KM4) *One resident said that brackish water will not go beyond the dam into the pond area. This contradicts what VHB told me about how far the salt water will encroach into the pond (2200 ft?). Is this resident even mildly correct?*

Response: We are aware of the historical description of the dam site as a "falls," which calls to mind a steep waterfall that would block upstream tidal flow. We have seen similar historical descriptions applied to river geomorphic conditions which are better described as riffles or cascades, and so caution against relying too heavily on such accounts without further information. Our study developed detailed bathymetric mapping, completed a survey of tidal elevations under various conditions, mapped bedrock in the vicinity of the dam, and completed a detailed hydraulic and sediment transport model. These factors are synthesized in Section 3.2 and presented graphically in Figures 3.2-7 and 3.2-8. We present a conservative analysis which concludes that dam removal will allow tidal flow upstream of the current dam location. The extent of upstream tidal flow depends on various factors which are described in more detail in Section 3.2. We also wish to note that these two observations are not necessarily at odds – a "falls" may appear under low tide, but depending on the longitudinal profile of the river bed, the high tide would still be able to inundate this feature and extend upstream. That is the morphology that we expect will develop in this location.

KM5) *What is the strongest statement to make to the dam protectors regarding the health of the pond? They believe that the pond should not be dredged.*

Response: Under Alternative 3, without "Option 1- Pond Restoration Dredge," the water quality in the pond will continue to worsen, which would have adverse effects on the fish and other aquatic species. We provide further detailed discussion of this in our responses to Sally Tobias' and Jim Lawson's questions below.

KM6) *"They do not mention the UNH dam that is upriver and poses a greater impact to the health of the existing water way." Is this a true statement? It is in a facebook posting supporting leaving the dam in place.*

Response: Our study scope focused on the river reach impounded by the Oyster River Dam at Mill Pond, which includes the mainstem of the Oyster River to approximately Thompson Lane as well as Hamel Brook to a point just below the NH 108 crossing. The UNH dam is located approximately one mile upstream of these impoundment limits, and so would not be affected by either the stabilization or removal of the dam. It is important to understand that the hydrological model that our team built and that informs virtually all of our findings includes the entire Oyster River watershed, extending many miles above the UNH dam. While all dams have effects on their river environment, it is unclear to us what studies the commenter relies on to assert that the UNH Oyster River Reservoir Dam has a greater impact on the river than the Mill Pond Dam. We'd be happy to review any such analysis and offer further response if such studies are provided, but we believe it is would be appropriate to consider any issues separately from the questions addressed in the current Feasibility Study.

Questions from Sally Tobias on Tuesday, January 19, 2021:

ST1) *What happens to the impound area if we keep the dam and do not dredge over time? Specifically, what happens to the River channel in the impound over 5,10,15,20 ,50 years if the dam remains and no dredging occurs. How would not dredging effect invasive species taking root along the shore and in the non-dredged impound? What is the expected life span of the dam if option 3 is chosen? How is water quality effected over time with no dredging?*

Response: With the pond left in place and no dredging, dissolved oxygen levels are likely to remain the same or deteriorate further. Conditions that contribute to low dissolved oxygen conditions such as warmer water temperatures, increased algal biomass and organic matter accumulation on the pond bottom causing greater oxygen demand are only likely to get worse. Worsening dissolved oxygen conditions will result in less suitable habitat for fish and other aquatic organisms both in physical area and time over the growing season. These conditions will have an

adverse impact on existing fish populations and other aquatic species, and will likely create conditions that would adversely impact the aesthetic values and recreational opportunities in the impoundment.

The expected design life of the dam if Alternative 3 is chosen is 50 years. With a good maintenance and capital improvement program, however, the life span of the stabilized dam may be extended beyond this expected design life.

ST2) *Do we have an estimate for the remaining life span of the dam upriver from the Mill Pond (Wiswall)?*

Response: The first dam upstream from Mill Pond is known as the "Oyster Reservoir Dam" (NHDES #D071007). We do not have any specific information regarding its remaining life span, but note that this dam, classified as a Significant Hazard, is subject to regular NHDES inspections. The dam was apparently last inspected by NHDES on February 14, 2019. NHDES subsequently issued a Memorandum of Deficiency on

ST3) *What is the impact of the algae blooms that occur in the summer on air quality? Is this a health risk for individuals that live near the pond or walk there? I heard a story about a dog that jumped in a pond with algae bloom and died as a result. Is this something that can actually happen or is it urban myth?*

Response: There are a variety of algal groups, including blue-green, green, diatoms and others. Most do not create any significant air quality hazards. However, some cyanobacteria (which are sometimes referred to as "blue-green algae" but are in fact a group of photosynthetic bacteria) do create toxins, which have been linked to numerous reports of illness and pet fatalities after exposure around the country. Please also see our more detailed responses to Jim Lawson's comments regarding cyanobacteria for more information on this topic.

Questions from Carden Welsh on Thursday, January 21, 2021:

CW1) *How much money has the town spent on a) studies of the dam and the impact of removal of the dam, and/or studies of the Mill Pond and Oyster River that relate to the dam, and b) repairs of the dam, since we received the first notice of deficiency in 2002?*

Response: Based on information provided by the Durham Town Hall Business Office, we understand that since 2002, approximately $492,000 has been expended on studies of the dam and the Oyster River that relate to the dam, as well as a repair of the right embankment.

CW2) *What happens to the Milne Park Parcel if the dam is removed?*

Response: Milne Park is one of two town-owned open space parcels on the north side of Mill Pond. If the dam were to be removed, no direct impacts to either of these parcels would occur. However, the elimination of the pond would result in a habitat change from open water to more aquatic bed and emergent marsh habitat, with some degree of tidal action in the currently impounded reach. While the habitat transition would likely benefit biodiversity, the visual and recreational experience would be substantially different. Water depths are not expected to support motorized or non-motorized boating, except for shallow draft kayaks and canoes. While recreational fishing locations would decrease in Mill Pond with the dam removal, there would be an improvement in fish passage from the upstream portions into the tidal portions of the Oyster River. In this scenario, winter ice skating on Mill Pond would no longer be viable. However, birdwatching as a form of recreation would not be negatively affected, as the expected wetland habitats are home to numerous species of birds.

CW3) *What land specifically was given to the town by the community church in the years 1980 – 1992, and were there any agreements struck as to what the land was to be used for?*

Response: VHB does not have any information that could be helpful in answering this question. We understand that you intend to work with Councilor Welsh to clarify the question and provide an answer.

CW4) *Do we have or can we get records as to how much water passes over the Oyster River Reservoir Dam, upstream from the pond, by month over the past several years? Do we know how this compares to the amount of water flowing into the reservoir during those months? Could more water be released if the town requested it?*

Response: The Water Division of the Durham Public Works Department maintains detailed records of water withdrawals from the various sources supplying the Town's water system, including the Spruce Hole Well, the Lee Well, the Lamprey River and the Oyster River Reservoir (*i.e.,* "UNH Dam"). These records contain data on withdrawals from the Oyster River from September 2010 to February 2020. During this period of record, the data shows that the Oyster River Reservoir is used only occasionally. Prior to the addition of the Spruce Hole Well to the Town's water supply in 2015, the reservoir was used approximately 102 days per year, with average daily pumping of approximately 572,900 gallons per day (gpd), or about 6.0 percent of the median annual Oyster River flow. Since the activation of the new well, reliance on the Oyster River has decreased such that water was withdrawn from the Oyster River Reservoir approximately 75 days per year for the years 2016 to December 2019. During this latter period (most reflective of the existing condition), average withdrawals were approximate 154,700 gpd, or about 1.6 percent of the median annual flow.

CW5) *What percentage of UNH/Durham water has been supplied by the Oyster River, from the upstream reservoir, in each of the past five years?*

Response: Based on data provided by the Durham Water Division and analyzed by April Talon, PE, the percentage of UNH/Durham water that has been supplied by the Oyster River has varied from 0.98% in 2018 to 9.59% in 2020.

Percentage of Water Supplied by the Oyster River

Year	Annual Percent
2016	2.15%
2017	2.76%
2018	0.98%
2019	8.37%
2020	9.59%

CW6) *If the site of the dam is "the natural falls of the Oyster River at the head of the tide" as noted by the Durham Historical Commission, why do we now expect the tide to run so much higher upstream of the dam?*

Response: Please see our response to Councilor Marple's Comment #4.

CW7) *What is the expected downstream impact on oysters, eel grass and other flora/fauna if the dam is removed? Both in the near term (1-2 years) and the longer term.*

Response: Regarding the specific resources mentioned, the nearest mapped oyster reef is located downstream of the Durham WWTF, more than 1.5 miles downstream of Mill Pond. The nearest mapped eel grass bed is located within Broad Cove in Little Bay, more than 4 miles downstream. Dam removal is very unlikely to have measurable direct effects on these populations, given their location in relation to the dam and given the magnitude of the intervening tidal dynamics. The report discusses the benefits to anadromous fish species, which should be regarded as a very significant benefit of the dam removal.

Questions from Andrew Corrow on Thursday, January 21, 2021:

AC1) *In the rendering of the dam with it removed there is quite a bit of terrain on the right where the fish ladder was. Would it be possible, if the dam is removed, to keep a few of the "ribs" of the Amberson Dam so when we do the mitigation measures, such as interpretive signage, these can be seen as an example?*

Response: We believe that retention of at least one segment of the spillway is a reasonable suggestion and would likely be possible if the dam is removed. The specifics would need to be further analyzed during final design to ensure there would be no adverse effects related to hydraulics or erosion. Such a proposal would be subject to the review and approval of the NH Department of Environmental Services and the NH Division of Historical Resources.

AC2) *With sediment being released and moving down stream are there any scenarios where we would have to dredge further downstream, over time, like around the Old Landing Park? I was thinking specifically would increased sediment deposits effect all the boat moorings that are there?*

Response: The sediment transport simulations suggest that sediment may be deposited in a relatively short reach, roughly located between the Three Chimneys Inn and Durham Landing. If deposited uniformly across the river in this area, the deposition of sediment from upstream could reach a depth of between 0.5 and 1.5 feet after 50 years. In practice, tidal action, which cannot realistically be modeled with a 1-month computational time step, will disseminate the accumulated sediment over a wider range, reducing the height of deposition. Surely, the sediment will be distributed over a much wider area eventually, likely several thousand feet, even miles downstream. Thus, our analysis must be regarded as a conservative worst-case scenario. Even under this conservative approach, we do not believe, that dredging of the downstream reach would be necessary. Rather, we expect that the long-term impacts would be far less as tidal flushing in the Oyster River would remain the dominant process downstream. The volume of water that is carried up and downstream in the Oyster River daily as a result of tidal influences is much greater than the flow of water from the river. Tidal dynamics are complex phenomena, but a review of downstream geomorphology suggests that the delivery of additional sediment to the Oyster River would not create substantial permanent impacts.

Question from Sally Needell on Friday January 22, 2021: *Would it be possible to have a description of what can be expected to happen to the pond in the next two decades if the dam is stabilized and the pond is not dredged? It seems to me that we could expect more sediment to be deposited, for the pond water to become shallower, and thus warmer, for the dissolved oxygen levels to continue to decrease, for algal blooms to increase, and for shallow areas to become marshy and support insect life and more vegetation including invasives. Decreased water quality would cause a continued decrease in the fish population, and cause fish to die within the impoundment. Am I on the right track?*

Response: With the pond left in place and no dredging, dissolved oxygen levels are likely to remain the same or deteriorate further. Conditions that contribute to low dissolved oxygen conditions such as warmer water temperatures, increased algal biomass and organic matter accumulation on the pond bottom causing greater oxygen demand are only likely to get worse. Worsening dissolved oxygen conditions will result in less suitable habitat for fish and other aquatic organisms both in physical area and time over the growing season. These conditions will have an adverse impact on fish populations and perhaps other aquatic species, and will likely create conditions that would adversely impact the aesthetic values and recreational opportunities in the impoundment. With no changes to the current conditions, it is likely that anadromous fish migration will continue to decline as more sediment accumulates in the pond, water depths become shallower and water quality conditions continue to deteriorate.

Question/Comment from Andrew Corrow on January 25, 2021: *I think Peter Walker stated, when he briefed us, that the Section 106 review wouldn't even begin until the Council makes a decision. Is that right? How long do you think that will take?*

Response: We have initiated the Section 106 consultation process by submitting a Request for Project Review (RPR) to the NH Division of Historical Resources on behalf of the Town. We've also spoken with Nadine Miller (Deputy State Historic Preservation Officer) a few times to keep her up to date on the project. Often, the Section 106 consultation is not initiated until an alternative is chosen and a lead federal agency is identified. In this case, we felt it was important to submit the RPR as early as possible since the dam is listed on the State Register and because its historic significance has been an important topic of discussion within the community. This way, NHDHR would have an opportunity to comment as the Town Council deliberates, and the Council could consider their position in making its decision.

Once the final alternative is selected, VHB will be available to continue to work with the Town, NHDHR, and any Consulting Parties to complete a formal Determination of Effects analysis and to advance a Memorandum of Agreement (MOA) to specify the appropriate mitigation measures. We believe that *either* Alternative 3 or Alternative 5 would have "adverse effects" on the dam, albeit quite different in intensity, so we expect an MOA in either case. These next steps would require the involvement of a lead federal agency - most likely the US Army Corps of Engineers – since Section 106 is a directive to federal agencies, not to the state or town.

Question/Comment from Jim Lawson on February 2, 2021: *Councilor Lawson provided a detailed set of questions, with supporting background.*

Response: Due to the length of Councilor Lawson's document, we have appended it to this memo with our response to each of his 19 questions.

Comments and Questions of Jim Lawson, February 2, 2021

Some members of our community are advocating that the dam should be stabilized and the Mill Pond should remain, without dredging, recognizing that the pond will inevitably change over time due to sediment deposits and other factors. Questions 1 through 9 are related to this scenario which was not one of the Alternatives selected by the Town Council for further investigation in the Oyster River Dam at Mill Pond Feasibility Study.

Background for Questions 1 – 3. Cyanobacteria (blue green algae) grows in water with temperatures between 20C and 35C, with the optimal temperature for growth being 27.2C *("Comparison of Cyanobacteria and Green Algae Growth Rates and Different Temperatures", Freshwater Biology 58, 552-559, 2013, Miquel Luring Et Al*.). Environments most conducive to cyanobacteria growth are calm and nutrient-rich waters (*EPA, Epidemiology and Health Effects of Cyanobacteria, Epidemiology & Health Effects of Cyanobacteria | Water Research | US EPA*). Cyanobacteria is harmful to humans, pets and livestock. Exposure routes include contact, ingestion and inhalation. The symptoms of cyanobacteria exposure include the following *("Facts about cyanobacteria exposure harmful algae bloom for poison control professionals", US Centers for Disease Control*):

Ingestion: Gastrointestinal (GI) effects include nausea, vomiting, diarrhea, and mild liver enzyme elevations. The time to onset of GI symptoms after oral exposure is usually 3–5 hours and symptoms can last 1–2 days. Exposure can cause conjunctivitis, rhinitis, earache, sore throat, and swollen lips. Respiratory effects can include atypical pneumonia and a hay fever-like syndrome. Exposure can also cause electrolyte imbalances, headache, malaise, and muscle weakness/ pain in joints and limbs. Hepatic failure has been reported in dialysis patients treated with dialysis water contaminated with mircocystins. Glycosuria, proteinuria, and occasionally hematuria also have been reported.

Inhalation: Rhinitis, sore throat, bronchospasm, pneumonia

Skin contact: Dermatitis, perioral blisters

Eye exposure: Conjunctivitis, lacrimation, swelling, photophobia

Table 3.5-2 and Figure 3.5-3 in the Oyster River Dam at Mill Pond Feasibility (the "Study") show summertime temperatures in excess of 20C and often in the range of optimal cyanobacteria growth. Section 3.5 of the study details that the Mill Pond is nitrogen impaired with phosphorus levels 2-3 times the recognized threshold for ponds. The 2014 study "Durham Ponds Assessment and Plan" observed cyanobacteria genera in Beards Pond, Little Hale Pond and the Mill Pond.

Question 1 – Will this scenario create a pond environment more conducive to cyanobacteria blue-green algae growth? What is the expected and worst case, if any, for blue-green algae blooms?

Response: *Although the Feasibility Study did not specifically investigate whether or not cyanobacteria currently exists within Mill Pond, a previous study had noted their presence. If the pond remains as is without any modifications or dredging, the presence and abundance of cyanobacteria in the pond will likely either remain unchanged or potentially increase in the future. As noted in the comment, EPA research has indicated that cyanobacteria are most prevalent in nutrient rich lakes and ponds with extended periods of warm water temperatures. The nutrient inputs to Mill Pond are likely to continue*

unless extensive source reduction measures are implemented in the watershed. Even if source reduction measures are implemented, nutrients contained in the bottom sediments and those released during the annual plant die-off are likely to be sufficient to sustain cyanobacteria. Certain cyanobacteria species have also adapted to "fix" nitrogen from the atmosphere to fuel growth and primary production. Based on recent Mill Pond water quality monitoring data, Dr. Wil Wollheim, Director of the UNH Water Systems Analysis Group and a member of the VHB Team conducting the Feasibility Study, has indicated that there is evidence that N fixation in the pond (through the N2:Ar measurements) is currently occurring and cyanobacteria are main type of nitrogen fixers in ponds, especially if there is enough nutrient supply. His laboratory has not yet analyzed for SRP in the lab due to COVID, but there is a lot of sediment deposition which often have a lot of sorbed P, and when the waters get anoxic, P is desorbed from sediments or redissolved from iron phosphates. We know DO is low, so P release seems likely.

The worst case scenario is that cyanobacteria will become more prevalent as the pond continues to fill in with sediments which will allow water temperatures to become even warmer and for longer periods as shallower water depths means less water volume to absorb heat from the sun, leading to warmer water temperatures. Ultimately this could result in more extensive cyanobacteria growth forming noticeable blooms of green scum or floating mats on the pond surface during low flow periods when there is limited flushing or exchange of pond water. Similar blooms and floating mats have been observed in other lakes and ponds in the region, and most notably in Lake Champlain. These blooms are not only toxic to humans and animals but can consume more dissolved oxygen and a release more nutrients during the die-off when the bloom crashes. The extensive algal biomass can create a noxious odor during the decomposition process.

Question 2 – What type of recreational activities would be restricted on the pond during a blue-green algae bloom? For example, should the town restrict kayaking and canoeing which the State of Vermont lists as a moderate health risk due to the inhalation of cyanobacteria toxins during an algae bloom?

Response: *If cyanobacteria blooms do occur, the Town may want to consider posting signs to inform the public about the risks of swimming and boating activity given the reported potential short-term gastrointestinal and long-term neurological health effects linked to cyanobacteria. UNH's Dr. Haney has published research that suggests a possible link between blue green algal blooms and long-term, debilitating neurological effects similar to amyotrophic lateral sclerosis (ALS).* [1]

Question 3 – Some research, although not conclusive, has shown a possible link between blue-green algae and amyotrophic lateral sclerosis (ALS), including ALS clusters around several blue-green algae impaired New Hampshire lakes *("Are Algae Blooms Linked to Lou Gehrig's Disease" Lindsey Konkel, Scientific America, December 2014*). What would be Durham's legal responsibility and likely course of action if the Mill Pond experiences blue-green algae blooms *and* a conclusive link is shown between the algae and neurological diseases?

Response: *We understand this has been referred to the Town's attorney for review, as it is a legal question rather than a technical issue.*

---

[1] See: *http://unhmagazine.unh.edu/sp09/dangerous_waters.html or https://www.scientificamerican.com/article/are-algae-blooms-linked-to-lou-gehrig-s-disease/*

Background for Questions 4 - 6. Section 1.3 of the Study states that the Mill Pond is habitat to nine fish species of concern listed on New Hampshire's Wildlife Action Plan. Section 3.5 of the Study also details that dissolved oxygen is below WQ-1703.07(b) thresholds.

Question 4 – Will the dissolved oxygen in the Mill Pond improve or deteriorate under this scenario?

Response: *With the pond left in place and no dredging, dissolved oxygen levels are likely to remain the same or deteriorate further. Conditions that contribute to low dissolved conditions such as warmer water temperatures, increased algal biomass and organic matter accumulation on the pond bottom causing greater oxygen demand are only likely to get worse. Worsening dissolved oxygen conditions will result in less suitable habitat for fish and other aquatic organisms both in physical area and time over the growing season as well as increased potential for release of phosphorous from the sediments to the water column.*

Question 5 – What will be the probable impact to the nine fish species of concern listed on the Wildlife Action Plan under this scenario?

Response: *The probable impact will depend on the both the sensitivity and life cycle of the fish species and the magnitude to which conditions worsen with respect to low dissolved oxygen and warmer temperature. However, any further decline in habitat conditions will certainly have an adverse impact on fish populations, and perhaps other aquatic species supporting these populations.*

Question 6 – What will be the long term impact to anadromous species using the Oyster River under this scenario?

Response: *With no changes to the current conditions, anadromous fish populations would be expected to continue to decline as more sediment accumulates in the pond, water depths become shallower and water quality conditions continue to deteriorate.*

We note that some public comments supporting Alternative 3 have provided testimony that we believe incorrectly blames deficient operation of the fish ladder for the declining anadromous fish population. These observations simply do not comport with basic facts related to the design and intent of the fish ladder as reported to us by fish passage experts at NHF&G. Most notably, these comments seem to assume that the ladder is intended to provide downstream passage. That is not the case. Its design and intended function is to provide upstream passage. The fish ladder has been operated each year since 1976, typically from April to as late as July – during the spring upstream river herring migration. The specific timing of the ladder operation is based on close monitoring of the anadromous fish run throughout the spring season by NHF&G fish biologists, who make observations throughout the seacoast region and have an intimate understanding of this resource. The general consensus among the fisheries experts familiar with this watershed is that declining water quality and habitat conditions are the most significant reason for the decline of the anadromous fish run.

Background for Questions 7– 9. Section 3.5.1.3 details nitrogen dynamics and presents data for the Total Dissolved Nitrogen in the Mill Pond. In 2018, it appears the pond released more nitrogen into the Great Bay estuary than it retained due to the ponds production of organic nitrogen from the die off of certain algae species.

Question 7 – Is the total organic nitrogen load released into the Great Bay likely to increase or decrease under this scenario?

Response: *If the dam remains in place and with no dredging, the current nitrogen dynamics with some periods of Total Dissolved Nitrogen (TDN) retention and other times releases over the course of a year are not likely to change much for the foreseeable future. Eventually, if sediment continues to accumulate and the system transitions from pond to channel/floodplain (without dredging), the nitrogen dynamics will function like a free flowing river system where whatever nitrogen comes in will go out in the same time, as if the dam was removed. The overall annual load to the Great Bay is not expected to change significantly unless there is a major spike in the abundance of blue-green algae that can "fix" or assimilate nitrogen from the atmosphere. If this occurs, nitrogen contained in the biomass could be released downstream during the annual die-off, which could result in a net increase in the annual load.*

Question 8 – From a nitrogen perspective, is the Great Bay Estuary better or worse off with this scenario compared to removing the dam (alternative 5)?

Response: *With respect to the Great Bay, keeping the dam or removing the dam is not likely to have a measurable impact on nitrogen loading to the Great Bay. Although Dr. Wollheim's water quality monitoring results indicated there is retention of dissolved inorganic nitrogen (DIN) during the summer months under current conditions, but that this retained DIN is eventually converted to DON and released downstream. If the dam remains in place, the pond will eventually fill in and have less open water for algal production such that the nitrogen inputs entering from upstream will be released downstream with little if any temporary delay or retention. In the more near team, as discussed above, the relative abundance of blue-green algae could have even greater influence on nitrogen output.*

Question 9 – Section 3.5.2 states "Under Alternative 1 – No Action, water quality conditions would remain the same with continued periods of low dissolved oxygen, elevated water temperatures and extensive algae and aquatic plant growth." To clarify, would dissolved oxygen levels and temperatures really remain the same, or would they deteriorate further?

Response: *Without dredging, as stated above, water temperatures will likely get warmer earlier in the season and rise more quickly following the occasional flushing due to precipitation events particularly as water depths become shallower over time. Shallower waters and reduced water volumes will allow for quicker heat exchange. Warmer water temperatures contribute to lower dissolved oxygen levels which may also be adversely influenced by the increased sediment oxygen demand.*

Background for Questions 10. Tables 3.26-16 to 19 summarize sediment transport for the median annual flow and various flood events.

Question 10 – Is it correct that the modeling shows that leaving the dam in (no action) results in the accumulation of sediment in the impoundment for every scenario modeled except the 100-year flood?

Response: *With respect to the Mill Pond portion of the impoundment, the sediment transport model predicts that there would be no sediment lost or gained by Mill Pond during median flow or 2-year flood conditions. A small amount of sediment is gained during the 10-year flood and about three times that amount is removed from the pond during the 100-year flood. To provide additional detail, we offer the following:*

- ***Median Annual Flow:*** *Table 3.2-16 indicates that, under Alternative A – No Action, no sediment is*

expected to enter or exit any part of the impoundment during median flow conditions.

- ***2-Year Flood Event:*** *Table 3.2-17 indicates that, during the 2-year flood, the Mainstem of the Oyster River (upstream of the main body of Mill Pond but some of which is impounded) will lose 2,811 ft^3 of sediment, with nearly all of it being deposited in the Middle Impoundment Reach between Mill Pond and the confluence of the Oyster River and Hamel Brook.*

- ***10-Year Flood Event:*** *Table 3.2-18 indicates that, during the 10-year event, a substantial amount of sediment is mobilized from the Mainstem of the Oyster River above Mill Pond (some of which is impounded). Much of that sediment is deposited in the Middle Impoundment (12,759 ft^3), but some 352 ft^3 of sediment is predicted to be deposited in Mill Pond, with some sediment escaping the impoundment and continuing into the tidal zone. Approximately 93% of sediment deposited downstream of NH 108 originates from below the dam.*

- ***100-Year Flood Event:*** *Table 3.2-19 indicates that, during the 100-year event, a substantial amount of sediment is mobilized from the Mainstem of the Oyster River (some of which is impounded), with a small amount mobilized from Hamel Brook. Approximately 63% of the sediment mobilized from these upstream areas is deposited in the Middle Impoundment. The remaining 37% of sediments transported from these upstream areas combines with 860 ft^3 of sediment originating in Mill Pond (likely in the floodplain areas since the dam is overtopped) and 1,884 ft^3 of sediment from the area between the dam and NH 108, all of which is deposited downstream of the state highway crossing.*

Questions 11 through 19 are related to Alternative 5 – Dam Removal.

Background for Questions 11 - 12. Section 1.3 of the Study states that the Mill Pond is habitat to nine fish species of concern listed on New Hampshire's Wildlife Action Plan.

Question 11 – What will be the impact to the nine fish species of concern listed on the Wildlife Action Plan under this scenario of dam removal and river restoration?

Response: *The nine fish species within the watershed include diadromous species, which spend part of their life cycle within freshwater and part within salt water, most notably river herring (predominantly blueback herring with some alewives) and rainbow smelt. The removal of the dam, which is a barrier to up and downstream fish passage, would provide an obvious and significant benefit to these species. Benefits to diadromous fish populations have been documented through the removal of numerous dams in the northeast (and throughout the country), and is the reason why so many fisheries agencies at the state and federal level are strongly supportive of dam removals. Section 3.12 of the Feasibility Study provides some discussion of the banded sunfish* (Enneacanthus obesus) *and swamp darter* (Etheostoma fusiforme)*, two other special concern species that have been documented from within the impoundment, near the confluence of the Oyster River and Hamel Brook. Although habitat for these two freshwater residents would be affected if the dam were removed, we expect these species to persist within the river. As we have said during our comments before the Town Council, as well as the Conservation Commission and the Historic District Commission, dam removal is perhaps the most powerful tool we have in the effort to restore native riparian habitats.*

Question 12 – Will there be suitable habitat for the anadromous fish species to survive and spawn between the tidal waters, which would extend to Thomas Lane, and the upstream dam at the UNH water treatment facility?

Response: *To clarify, our study indicates that the current impoundment of the mainstem of the Oyster River extends approximately to Burnham Lane near where the new pedestrian bridge has been installed. If the dam were to be removed, we conservatively predict that tidal flow could reach as far upstream as the confluence of the mainstem with Hamel Brook (perhaps once per month). At least 2.6 river miles of stream habitat would be restored to a free-flowing condition if the dam were to be removed, including approximately 1.8 river miles on the Oyster River mainstem, 0.4 mile of Hamel Brook and 0.4 mile of College Brook. This represents valuable spawning habitat for anadromous fish. In addition to obvious benefits to the river herring (*Alosa *spp.) population, rainbow smelt* (Osmerus mordax) *habitat is expected to increase significantly. These fish typically spawn in riffle habitat near the interface of salt and freshwater and for a short distance upstream. The current presence of the dam significantly limits this habitat type.*

Background for Questions 13 - 16. One of the four parts of the plan for Dam Removal is abutment preservation.

Question 13 – What type of on-going maintenance will the abutments require?

Response: *From an infrastructure standpoint, maintenance requirements would be limited. These structures would be preserved primarily for historical purposes and provide limited structural function. Exceptions to this could be:*

- *Long term stability of the right abutment wall and features and impacts failure would have on the abutting property.*
- *Safety considerations for members of the public that visit the site.*
- *Considerations if the Town wants to continue to maintain the remnants as interpretative relics of the dam indefinitely.*

Please note that in response to a question from Councilor Corrow, we have indicated that it may be possible to preserve some portion of the Ambursen-style dam spillway in addition to the abutment preservation currently included in the conceptual plan for Alternative 5.

Question 14 – During some flood events, the property at 20 Newmarket Road will experience flooding. Are the left and right abutments likely to be damaged in a 10-, 50- or 100-year flood?

Response: *Based on the hydraulic modeling conducted to date, flood damage is unlikely since during high flow events the NH 108 bridge creates a backwater which significantly reduces velocity at the abutments. However, if remnants of the spillway extend into the channel for any distance, they may experience increased scour potential and be subject to damage. If necessary, it may be possible to modify the grading plan or include scour countermeasures to mitigate risk. This question would be resolved quite definitely based on updated hydraulic modeling and engineering calculations that would be required to complete a final design.*

Question 15 – Who is responsible for maintenance and repair of the abutments?

Response: *Since the Town owns the existing structure, we assume the Town would continue to be*

responsible for any remnants left in place, unless some other arrangement can be reached with a third party. Any such agreement may be subject to the approval of the NHDES Dam Bureau.

Question 16 – If the town is responsible, does the town have the necessary easements across property at 14 and 20 Newmarket Road to perform maintenance and repair?

Response: *This is a legal question, which should be reviewed by the Town's lawyer, as it is a matter of legal interpretation of a set of underlying deeds. However, we assume that the deed conveying ownership of the dam to the Town conveys rights of access to maintain and repair the dam. We don't believe the act of removing the dam would alter those rights.*

Background for Questions 17- 19. Sections 2.8 "Active Channel Restoration" recommends channel shaping with the possible removal of 3,000 cubic yards of sediment. Section 3.3.3.1 states that PAHs and/or metals are found throughout the sediments in the study area. Section 3.3.3.2 states that sediments exceeding the S-1 standards "generally suggest additional assessment and/or risk mitigation… should excavated/dredging of sediments be proposed as part of the selected alternative."

Question 17 – What engineering and/or regulatory processes are in place to assure residents that the 3,000 cubic yards will be processed safely, and that the work will not release unsafe toxins during or after the channel restoration?

Response: *Please see our response to Councilor Burton's question, which attempts to clarify some of the issues related to observed levels of PAHs and metals within, above and below the impoundment.*

More specific to the question of processes and safeguard, any sediment to be removed from the river as part of the project they would become classified as soils and would then be subject to review in accordance with NHDES "Contaminated Sites Risk Characterization and Management Policy (RCMP)." *The RCMP is a process to characterize soils to determine if detected contaminant concentrations constitute a direct contact risk to humans or a potential risk to groundwater quality and identify appropriate actions necessary to eliminate or mitigate any direct exposure risks and eliminate any potential risk to groundwater quality. Sediment/soil analytical data exceeding the S-1 standard (equivalent to the Soil Remediation Standard established in Env-Or 600 Contaminated Site Management) warrants risk elimination/mitigation actions. Further, sediment removed from the river that exceeds the Soil Remediation Standards (SRS) and is directly linked to a regulated release is subject to the requirements of Env-Or 600. Sediments removed from the river that contain contaminants at a concentration greater than the natural background, not solely due to the natural mineral content of the sediments, are subject to regulation as a solid waste in accordance with Env-Sw 903 if they are removed from the site.*

Pursuant to these regulations, we expect that NHDES would, as part of their review of any permit application that involves substantial sediment removal (either Option 1 - Pond Restoration Dredge or Option 2 - Active Channel Restoration) require a plan that identifies measures to manage this risk – including additional construction phase sediment sampling to ascertain how the soils should be handled and disposed. Please note that our cost estimates assume that some level of special soil management and disposal would be required.

In addition to the RCMP review, the NH Wetlands Bureau will require very detailed plans to ensure that the dam removal and active channel restoration is conducted in a manner that would prevent any construction-related turbidity or sedimentation – such occurrences would be considered violations of the state water quality standards at RSA 485-A and the New Hampshire Code of Administrative Rules Chapter

Env-Wq 1700. These measures are expected to include the following:

- *Detailed engineering drawings of the proposed action, subject to the review of specialists within NHDES and its sister agencies.*
- *Regular inspections of the construction by a qualified professional that would be retained to ensure that the project is constructed in accordance with the approved plans. These inspections would be detailed in a detailed "Project Monitoring Plan" which would be subject to the review of the NHDES and its sister agencies.*
- *A preconstruction meeting with the Town of Durham, its selected contractor, the independent construction monitor, and the various resource agencies including NHDES, NHF&G, US Army Corps of Engineers and other interested agencies. It is likely, given the high profile nature of this project, that regular follow up inspections with these agencies would occur.*
- *It is highly likely that the NHDES would require all work in the river to be constructed in the dry, behind a sealed cofferdam. We have provided some preliminary information on the likely location of such a cofferdam in our conceptual plan for Alternative 5. This would essentially prevent the risk of unnecessary turbidity or sedimentation.*

I encourage Councilor Lawson, his fellow Councilors, and members of the public to recognize that the plans developed to date for Alternative 5 are, in fact, necessarily conceptual in nature and that our analysis of risk is appropriately conservative. The fine details of the engineering plans, including construction phasing, dewatering, sediment and erosion controls, and monitoring are always developed during a final design and permitting phase which follows the selection of an alternative. We are confident that these provisions will appropriately manage any risks.

Question 18 – What is done during a channel restoration process to mitigate harm to fish and wildlife?

Response: *The measures described above will not only control sedimentation, but will also help to mitigate harm to fish and wildlife. Additional measures would also be developed in consultation with the experts at NHDES, NHF&G, NHNHB, NOAA, USFWS, and the Corps of Engineers. Such measures could include:*

- *A time of year restriction on the construction work to avoid impacting the river during migratory or spawning periods;*
- *Early drawdown of the impoundment, coordinated with field surveys to locate any aquatic or benthic animals (shellfish, for example), with relocation of these animals outside of the work area;*
- *Careful project planning related to river access to minimize the disturbance footprint;*
- *Requirements to avoid disturbances to migratory waterfowl breeding and nesting areas as well as migratory fish spawning and rearing habitat;*
- *Provisions to remove invasive species from the work area, and for the contractor to follow the NH Best Management Practices for Roadside Invasive Species (2008) to avoid introducing any new invasive species; and*
- *Coordination with NHDES, NHFG, NOAA/NMFS, USFWS to adaptively manage the project within the project reach to optimize river restoration potential and take remedial actions as may be necessary.*

Question 19 – Will sediments exceeding the S-1 standards in the dewatered Hamel Brook reach require further study, or are the recreational exposure scenarios so limited that further study and mitigation are not necessary.

Response: *The sediments within the dewatered Hamel Brook reach would not require any further study in our opinion. Our assessment indicates that the reported concentration of arsenic in sample SED1 within the Hamel Brook reach slightly exceeds the S-1 standard for that constituent (11 mg/kg). This sample detected arsenic at a concentration of 12 mg/kg, within the range of reported concentrations for other samples in the study which ranged from 7 to 17 mg/kg. This relatively narrow range of arsenic concentrations and their consistent spatial distribution are indicative of a naturally occurring background condition. Therefore, we conclude that newly exposed sediments are unlikely to represent an additional or unacceptable risk to human health.*