E. Response to Comments Concerning the Proposed New Outfall and Diffuser

Introduction to Section E

In order to provide context for the responses that follow, EPA briefly summarizes the relevant history underlying the permit renewal and variance application process, and outlines in broad strokes the responses to some of the points that appear under different rubrics in multiple comments.

Mirant Kendall submitted a permit application which requested permission to discharge heated water from (1) its existing outfalls and (2) a proposed diffuser to be constructed at the river bottom. Pursuant to CWA § 316(a), Mirant Kendall also requested a variance from the applicable temperature water quality standards for both in-stream temperature and ΔT.

In advocating its diffuser proposal, Mirant Kendall postulated that the physical force of the water discharged from the diffuser would mix the deep saline layer with the fresh water above and thus destratify the Basin. For this reason, EPA was initially receptive to the diffuser proposal, pending appropriate modeling of the diffuser's impact. EPA recognizes that, if the proposed diffuser would in fact destratify the Basin – which, as explained below, Mirant Kendall has not established – some environmental benefits would result, principally the oxygenation of portions of the water column that are presently anoxic.

However, EPA expressed concerns that the same physical forces, and the same mixing, could also yield negative impacts on the Basin that might well outweigh the benefits. Specifically, as EPA communicated to Mirant Kendall on numerous occasions, EPA's preliminary analyses indicated that the proposed diffuser's operation could result in liberation of phosphorus currently trapped beneath the pycnocline (top of the deep salt water layer), and that the dispersion of this phosphorus into the upper water column could result in accelerated eutrophication. In addition, the effect on fish and zooplankton of increased salinity due to mixing of the salt layer with overlying water was not adequately addressed.

EPA asked Mirant Kendall to model the impacts of the proposed discharge with respect to nutrient flux and eutrophification in order to assess the potential for increased severity of algal blooms. While Mirant Kendall did submit some modeling results, EPA's scientific and engineering staff concluded that the modeling programs were in some cases plainly inadequate, and in other cases potentially acceptable but not a reliable source of information without validation from known data. Specifically, EPA expressed the following concerns:

- Mirant Kendall's eutrophication model was technically deficient and could not be calibrated to existing data. EPA specifically asked Mirant Kendall to calibrate the model to 1998 and 1999 data, produce transient model simulations of future conditions using 1999 data, and use the model to evaluate whether reductions in heat loads are necessary to achieve various target chlorophyll *a* levels. See Letter from Michael Hill, Office of Ecosystem Protection, EPA, to Norm Cowden, Project Director, Mirant Kendall (July 9, 2001). Mirant Kendall never did this.

- Mirant Kendall's dissolved oxygen model was calibrated using unrepresentative data collected at times when algae were producing oxygen and had in fact supersaturated the water column. As a result, the model overpredicts dissolved oxygen levels during conditions of less or no photosynthetic activity (e.g., less sunlight, less algae, or pre-dawn conditions). Moreover, the model assumes, contrary to EPA's explicit goal (through the ongoing TMDL process, not this permit renewal) of eventually reducing the severity of algae blooms in the Basin, that the high algae levels necessary to supersaturate the water column with dissolved oxygen will continue indefinitely. Furthermore, Mirant Kendall's model did not account for the increase in water temperature that would result from the bottom thermal discharge. An increase in temperature will cause higher oxygen demand which will result in lower dissolved oxygen in the lower water column. EPA specifically asked Mirant Kendall to recalibrate the dissolved oxygen model with more representative data, test it with an independent data set, and run the recalibrated model taking the potential increase in temperature into account. See Letter from Michael Hill, Office of Ecosystem Protection, EPA, to Norm Cowden, Project Director, Mirant Kendall (July 9, 2001). Mirant Kendall never did this.

- Mirant Kendall's thermal model consistently underpredicted observed temperatures by approximately 2° F at almost all monitoring stations. Rather than recalibrate the model by adjusting input parameters to better match observed data, Mirant Kendall simply added 2° F to the model output for all cells. After consulting with MA DEP, MA DMF, MA CZM, and NMFS, EPA concluded that this was scientifically inappropriate because the factors controlling the temperature in the Basin are most likely nonlinear. EPA specifically asked Mirant Kendall to adjust the input parameters to reflect site conditions more accurately and to model certain conditions. See E-mail from Mark Voorhees, Office of Ecosystem Protection, EPA to John Reynolds, Mirant Kendall (January 15, 2003); Letter from Michael Hill, Office of Ecosystem Protection, to Norm Cowden, Project Director, Mirant Kendall (July 16, 2001). Mirant Kendall never did this.

- Mirant Kendall's model of the diffuser's discharge and mixing effect used a novel, unvalidated technique to compute vertical momentum. (Most hydrodynamic transport models involve nearly horizontal discharge.) While EPA does not necessarily disagree with the technique, until the model is adequately validated EPA holds serious reservations about the accuracy of the model's predicted impacts. Under the present circumstances, EPA found it inappropriate to rely on a novel, unvalidated modeling technique and therefore had no reliable diffuser model. EPA timely expressed these reservations to Mirant Kendall (AR #169, 209, and 314).

Although EPA communicated these concerns to Mirant Kendall, Mirant Kendall elected not to revise, recalibrate, or validate its models, nor to propose alternative designs that might reduce the risks described by EPA. Indeed, Mirant Kendall eventually acknowledged that "the eutrophication model has fundamental inaccuracies in its prediction algorithms (especially related to the effects of temperature on algal growth in the lower Basin) that will not be eliminated through more refinement of the model." Letter from Norm Cowden, Project Director, Mirant Kendall, to Michael Hill, Office of Ecosystem Protection, EPA (December 20, 2001); see also Letter from Robert W. Varney, Regional Administrator, EPA, to John P. Reynolds, Mirant Kendall (October 6, 2003). Instead, Mirant Kendall requested that EPA abandon relying on models for permit development, and instead develop a permit based on monitoring real-time compliance. See Letter from Norm Cowden, Project Director, Mirant Kendall, to Michael Hill, Office of Ecosystem Protection, EPA (December 20, 2001); see also E-mail from Mark Voorhees, Office of Ecosystem Protection, EPA to John Reynolds, Mirant Kendall (January 15, 2003).

Thus, the available evidence suggests that the proposed diffuser would increase circulation of phosphorus through the water column, and that this in turn would increase algal blooms – particularly of noxious blue-green algae that tend to displace other, less objectionable species some of which contribute to the food web that supports fish such as river herring. Mirant Kendall's failure to develop reliable models meant that EPA had no reason to doubt its own analyses. Accordingly, EPA determined that the operation of the proposed diffuser would have a reasonable potential to cause or contribute to excursions above the eutrophication related state water quality standards and lead criteria. For that reason, EPA denied the diffuser proposal.

In parallel to, but distinct from this permit renewal process, the lower Charles River Nutrient TMDL effort produced a model of existing conditions in the lower Basin in late 2005. EPA determined that this model could be appropriately modified to model the proposed diffuser. Mirant Kendall has chosen to incorporate the diffuser into the model developed for the eutrophication TMDL, and EPA has provided assistance to Mirant Kendall in initializing the model. In response to Mirant Kendall's decision to pursue performing the diffuser modeling analysis, EPA has outlined its expectations for the diffuser modeling analysis, including scenarios that should be performed. As noted repeatedly throughout the Determination Document and these responses, EPA is willing to consider a renewed application for permission to discharge through a proposed diffuser if and when Mirant Kendall submits credible modeling results. Until that time, however, EPA is proceeding on the basis of available information. (See also responses A12 and A13).

Starting in February 2006, Mirant Kendall began work on a modeling analysis for the proposed diffuser. EPA has provided written guidance to Mirant Kendall on the required scope of the analysis as well as identifying key interim steps in the analysis that will require EPA review and approval. Based on initial work, Mirant Kendall has provided some limited and preliminary results of the modeling analysis to EPA and MassDEP and has requested that this information be considered by EPA and MassDEP prior to issuing the final NPDES permit. EPA has reviewed the information and has found it to be cursory and insufficient to evaluate the impacts of the operation of the proposed diffuser on water quality in the lower Charles River. The information provided falls far short of the technical documentation requirements that EPA had previously identified to Mirant Kendall as being necessary to fully evaluate the proposed diffuser. Therefore, EPA considers the recent modeling results provided by Mirant Kendall to be premature and unsupported for evaluating the diffuser impacts. EPA understands that Mirant Kendall intends to continue to work on the diffuser analysis. EPA will continue to communicate with Mirant Kendall concerning the diffuser modeling analysis and the content of information needed by EPA to fully evaluate the proposed diffuser.

<u>Common themes in Mirant Kendall's Section E comments</u>

The following points surface in multiple comments under Section E, and while EPA provides detailed individual responses to each comment, the following brief summary may provide a helpful overview.

- Mirant Kendall argues in several comments (especially E4-E12) that its proposed diffuser would have certain environmental beneficial effects. EPA has two general responses. First, EPA is not yet convinced, in part because of Mirant Kendall's failure to produce an acceptable model, that the diffuser actually would achieve these effects. Second, if it actually would achieve these effects, EPA agrees that the effects would be beneficial, but has concluded that these benefits are outweighed by the reasonable risk of increased dispersion of phosphorus and consequent increased eutrophication.

- Mirant Kendall argues in several comments (especially E13-E23) that EPA has misanalyzed the dynamics of algal blooms, and suggests alternative explanations. As explained in detail in Attachment A to the Draft Permit, multiple interdependent parameters influence algal growth and these variables sometimes move in opposite directions, making the problem complex. Furthermore, each year is unique. However, EPA's analysis (as documented in Attachment A) indicates that, during mid-to-late summer, phosphorus is typically the limiting factor in algal growth. Mirant Kendall's data and competing hypotheses are problematic and unpersuasive.

- Ultimately, EPA has denied the diffuser proposal because Mirant Kendall failed to dispel well-founded concerns that the proposed diffuser would distribute phosphorus to the upper water column and aggravate an existing algae problem that already violates Massachusetts water quality standards. The reason Mirant Kendall has failed to dispel these concerns is largely of Mirant Kendall's own doing. EPA remains open to the theoretical possibility that scientifically acceptable computer models, based on accurate data and sound methodologies, could demonstrate that the diffuser proposal (or a modified design) would not have these effects. But Mirant Kendall's actual submissions to EPA do not inspire confidence and are not an adequate basis upon which to allow a massive source of vertical hydrodynamic transport from the base of a river in contact with phosphorus-heavy sediments to an upper water column already plagued with phosphorus-limited algae. Until Mirant Kendall provides a scientifically sound predictive model that shows the operation of the proposed diffuser will not result in increases in algal levels in the lower Charles River, EPA finds that the proposed diffuser has a reasonable potential to cause or contribute to an excursion above the eutrophication related state water quality standards.

Specific comments and responses follow.

Comment E1: Mirant Kendall asserts that EPA is arbitrarily and capriciously denying the proposed diffuser, and thereby foregoing the environmental benefits of destratification, on the basis of exaggerated concerns about eutrophication. Mirant Kendall raises numerous distinct subpoints, but chiefly argues that (1) the regulatory agencies earlier agreed that eutrophication in the lower Basin is principally caused by low flow and high nutrients, which Kendall Station does not affect; (2) other permitting agencies, recognizing this fact, have already approved the proposed diffuser; (3) stratification in the Basin is a major stressor to the BIP, and therefore destratification would achieve significant environmental benefits; and (4) EPA has adopted contradictory objectives in that it aims to maintain the BIP, which depends in part on sufficient algae, and yet also aims to reduce that algae.

Response to E1: Mirant Kendall makes a number of inaccurate statements that mischaracterize EPA's position concerning eutrophication of the lower Basin and possible benefits associated with disruption of the salt wedge and destratification of the lower Basin.

1) Mirant Kendall incorrectly states that there was a consensus among the regulatory agencies and Mirant Kendall that eutrophic conditions in the lower Basin were principally a function of low flow and high nutrients. EPA is not aware of any document in the record supporting Mirant Kendall's recollection of a "consensus" among regulatory agencies and Mirant Kendall on this issue. At any rate, EPA – the regulatory agency charged with implementing the CWA in Massachusetts – never adopted such a position. To the contrary, EPA has maintained throughout the permit development process that eutrophication of the Basin is likely due to elevated nutrient levels, high river temperatures, and sufficiently long water residence time in the Basin (not just associated with low-flow conditions) (Tetra Tech, 2002).

Mirant Kendall has mischaracterized the extent of eutrophic conditions in the Basin by describing the perceived problems as "the occasional existence of eutrophied conditions during low flow events in late summer." First, low flow is not a phenomenon of a few isolated "events," but rather a persistent, recurring characteristic of the lower Basin. Second, water quality data demonstrates that eutrophication in the Basin is <u>not</u> limited to periods of low flow – it occurs during periods of average and even high seasonal flow.

First, the Basin typically experiences water residence times throughout most of the summer and into early fall that are sufficiently long to allow algal blooms to become established. Generally, annual high flows at Watertown Dam occur during the spring thaw period and annual low flows occur during the summer season, when growth conditions for algae (e.g., light intensity and temperature) are optimal. The decline in river flows that occur in the Basin during the summer period also favor algal growth because of the associated increase in water residence time and water clarity. The impounded lower Basin maintains a water volume of approximately 370 million cubic feet (Cowden, 2001) and tends to have relatively long water residence times (typically 4 to 10 weeks) during the summer months when river flow rates decline. As flows decline, the amount of time a unit volume of water spends in the Basin increases. Increased water residence time allows algae populations more time to grow and take advantage of the favorable sunlight, temperature, and nutritional conditions. Specific growth rates of algae are species and size dependent. However, algal doubling times (the time needed for the population to double in size) are typically on the order of a half day to a few days and may range from a few hours to several days (Kalff, 2001). As evidenced by the elevated chlorophyll *a* concentrations observed in the Basin during a variety of flow conditions (high, normal and low), water residence times in the lower Basin have been more than sufficient to allow algal blooms to become established.

Table E1-1 presents a summary of the average daily flows entering the Basin at Watertown Dam for the main summer and early fall growing season (July 1-Sept 30) of 1997-2004. Also included are two columns of estimated summer average water residence times of the lower Basin: one column assuming completely mixed conditions (i.e., without stratification), and another column assuming stratification based on an average observed pycnocline depth of 15 feet. When the water column of the lower Basin is vertically stratified, which occurs during the summer period, the water residence time is reduced by approximately 10 percent because there is less volume to be displaced by the incoming fresh water. The seven-day low-flow at the Watertown Dam that occurs approximately once every 10 years (7Q10 flow) and the historical average flow for this period along with the calculated residence times are also shown in Table E1-1.

Table E1-1. Summer average daily flow at Watertown Dam and water residence time of the lower Charles River Basin (July 1-September 30)

Year	Average Daily Flow At Watertown Dam (cfs)	Average Water Residence Time in lower Basin	
		Assuming no stratification (days)	Assuming stratification (days)
1997	37	118	104
1998	408	11	9
1999	165	26	23
2000	183	24	21
2001	202	22	19
2002	64	68	60
2003	311	14	12
2004	244	18	16
Historic average	229	19	14
7Q10	18	242	213

As indicated in Table E1-1, there is considerable variation in average summer flow conditions from year to year. The summers of 1997 and 2002 had drier weather and low-flow conditions (37 and 64 cfs, respectively), while 1998 and 2003 had more wet-weather and high-flow conditions (408 and 311 cfs, respectively). July through August of 1999 was also a very dry period and resulted in very low flows in the Basin until early September, when a series of larger rain events occurred and river flows increased substantially. Summer growing season average water residence times, assuming stratification, ranged from 9 days in 1998 to 104 days in 1997.

During the wetter years (1998, 2003, and 2004) the actual flows passing through the Basin were higher than shown in Table E1-1 because of the runoff from the tributary streams and drainage systems that directly enter the Basin below Watertown Dam. The effect on water residence time of the Basin during storm events is complicated by the operation of the New Charles River Dam. As part of its flood control procedures, operators of the Dam lower the water level of the Basin before a forecasted rain event to provide storage for the anticipated runoff from the watershed.

Moreover, the figures in Table E1-1 are not the result of occasional low flow "events" or outliers that drag down the seasonal average. Rather, extended periods of low flow are characteristic of the lower Basin during the summer growing season. In the Boston area, it is not uncommon to have extended low flow periods during dry weather in the summer months, during which the actual water residence times in the lower Basin exceed 70 days even when the Basin is vertically stratified. That happened in 1997, 1999, and 2002. Table E1-2 illustrates this. Table E1-2 summarizes average flows that occurred in the Basin for various extended periods of time during the summer growing season for each of the monitoring years. It also shows the maximum estimated actual water residence time (assuming stratification) that occurred in the lower Basin during the July 1 to September 30 period of each year based on the daily flow data. These results illustrate that it is normal for the Basin to experience long periods during the summer growing season when flows are noticeably less than the seasonal average flows.

Table E1-2. Charles River running average daily flow (cfs) at Watertown Dam for specified periods (July 1-September 30)

Year	20 Day	30 Day	40 Day	60 Day	Seasonal average cfs	Actual water residence time lower Basin days
1997	21	23	26	33	37	110+
1998	240	265	291	299	408	14
1999	24	27	27	46	165	75
2000	40	66	89	152	183	41
2001	36	58	85	125	202	40
2002	23	27	31	40	64	75
2003	194	205	219	292	311	20
2004	109	127	165	186	244	30

Notably, for every single year from 1997-2004, the 60-day running average daily flow was less – in some cases dramatically so – than the seasonal average. That means that low flow, far from being a phenomenon of occasional "events," is a persistent, recurring feature of the Basin in late summer.

Moreover, the chlorophyll *a* data collected from the Basin demonstrate that eutrophic conditions and algal blooms are not limited to low flow periods. Existing river flow and chlorophyll *a* data collected by the EPA and the MWRA show that high chlorophyll *a* levels that are indicative of eutrophic conditions have consistently occurred throughout most of the summer and into early fall (typically mid July to the end of October) under a wide range of flow conditions, including above average summer flow conditions (EPA, 1998-2004; MWRA, 1997-2004). These data are summarized in Tables E1-3 and E1-4. Elevated levels of chlorophyll *a* that are indicative of eutrophic conditions have been observed in the lower Basin during every summer monitoring season, including the very high-flow season of 1998. For example, on August 13, 1998 when the water residence time in the lower Basin was approximately two weeks, the observed chlorophyll *a* at MWRA station 166, located just upstream from the Museum of Science, was 37 µg/l. Tables 2, 3, and 4 in Attachment A of the Fact Sheet include literature values of chlorophyll *a* concentrations that are commonly used for evaluating the trophic status of surface waters. Both the seasonal mean and maximum chlorophyll *a* values for the lower Basin fall within the eutrophic classification for every monitoring season (1997-2004).

Table E1-3. Summary of EPA seasonal (July - October) chlorophyll *a* data for the Charles River Basin (1998-2004)

	Chlorophyll *a* (µg/l)						
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Lower Basin							
mean	15.1	27.1	23.5	24.6	18.4	18.4	24.0
median	10.9	16.1	26.7	25.4	16.4	19.4	26.6
min - max	4.5- 46.6	7.2- 97.0	5.0 - 41.0	4.7 - 47.7	1.5 - 41.5	3.3 - 47.7	4.4 - 55.4
number of surveys (s)	4	7	7	5	7	4	6
number of samples (n)	20	34	31	23	73	22	28

Notes: Lower Basin values represent data from EPA stations CRBL06, 07, 8A, 09, 10, and 11.

In 2002 the Lower Basin values also represent data from EPA stations TMDL21, 22, 23, 24, 25, 26, and 28.1. Chlorophyll a data have been corrected for pheophyton

Table E1-4. Summary of MRWA seasonal (July- October) chlorophyll *a* data for the lower Charles River Basin (1997-2004), as measured at MWRA Station 166 (upstream of Museum of Science)

Season (July-October)	Chlorophyll *a* µg/l Min - Max	Median	Mean	Number of observations
1997	17.6 - 88.2	37.8	44.8	18
1998	4.7 - 48.0	16	18.3	18
1999	5.1 - 87.6	19.2	25.7	17
2000	3.4 - 42.2	19.9	19.5	17
2001	5.3 - 45.5	26.8	25.3	18

2002	3.4 - 35.7	20.5	21.7	16
2003	7.4 - 39.1	21.8	22	8
2004	2.6 - 45.7	17	20	9
1997 - 2004	2.6 - 88.2	22.1	25.3	121

Mirant Kendall argues that because the Station's discharge does not add nutrients, eutrophic conditions in the lower Basin are not solvable by any changes that can be made to the Station's discharge, including its elimination. However, addressing eutrophic conditions in the Basin requires controlling a broad range of pollutants and other contributing factors. While nutrients are clearly an important factor that will require controls to address eutrophication in the Basin, they are not the only factor. Extensive water quality data collected in the lower Basin show that thermal pollution from Mirant Kendall's discharge raises temperatures in the downstream portion of the lower Basin by several degrees Fahrenheit during the critical summer months (July-October) and is, therefore, likely to be a contributor to excessive algal growth. Also, higher temperatures favor the growth of noxious blue-green algae species, some of which are toxic and capable of outcompeting other algal species. Algal data collected from the lower Basin show that blue-greens become the predominant species of algae in the river between Longfellow Bridge and the Museum of Science during the later portion of the summer season (see response to E19). A very severe blue-green algal bloom (consisting of over 1 million cells per milliliter of microcystes, a blue-green species known to be potentially toxic) occurred in this segment of the river during an extended period of warm weather in August of 2006. During this period, surface water temperatures were very elevated because of the facility's thermal discharge.

Similarly, dispersing phosphorus that has been released from the bottom sediments and is presently trapped beneath the pycnocline would likely contribute to excessive algal growth. See Attachment A to the Draft Permit Fact Sheet. Consequently, limits on the thermal load discharged to the lower Basin, and the manner in which the load is discharged, may be necessary during certain periods of the growing season to reduce the severity of eutrophic conditions in the lower Basin.

2) Mirant Kendall notes that other regulatory agencies implementing different permit programs have granted approval to construct the proposed diffuser. However, the agencies issuing these permits did not purport to evaluate the proposed diffuser's potential long-term effects on water quality. In fact, the Army Corp of Engineers deferred consideration of potential water quality issues associated with operation of the proposed diffuser to EPA and the NPDES permit renewal process by conditioning the Final Permit to prohibit construction of the diffuser until EPA issued a draft NPDES permit for the facility (Godfrey, 2002). Similarly, MA DMF asked the Corps not to issue the Final Permit until outstanding water quality issues related to the proposed diffuser were satisfactorily addressed (Schwartz, 2002; Malkoski, 2002). NOAA Fisheries (formerly NMFS) supported MA DMF's request (Hutchins, 2002).

Mirant Kendall claims that "several of those approvals mandate construction and use of the proposed outfall" and cites approvals from the Cambridge Conservation Commission and the Energy Facilities Siting Board as examples. These approvals did not "mandate" that the diffuser be constructed and used, but required, in the event a diffuser was to be installed, that construction be done so in accordance with the conditions of the permits and based on the plans and information submitted by Mirant Kendall during the permit application process. In fact, the Order of Conditions issued by the Cambridge Conservation Commission required that Mirant Kendall submit a NPDES permit before starting construction authorized by its permit (Cambridge Conservation Commission, 2000). Furthermore, in the City of Cambridge's October 14, 2004 comment letter on the draft NPDES permit, the City did not object to EPA's decision to deny the diffuser proposal. Rather, the City simply requested that EPA revisit the proposed diffuser in the future, when information and modeling capabilities become available, and to permit the operation of the diffuser if a future evaluation determined that the system would have a positive impact. See Comment related to E1 by City of Cambridge. EPA has carefully emphasized that its denial of the diffuser proposal at this time is without prejudice to a future application supported by credible modeling and/or a design aimed at minimizing water quality impacts.

3) Mirant Kendall argues that the proposed diffuser would eliminate the stratification of the lower Basin caused by salt water intrusion. Mirant Kendall argues that the stratified conditions are "a major stressor for the BIP," and claims that EPA "fully recognize[s]" this. EPA acknowledges that the water quality conditions within the salt wedge are generally unsuitable for supporting aquatic life uses. However, EPA disagrees with Mirant Kendall's analysis for three independent reasons: (1) the salt wedge occupies a relatively small portion of the total volume of the Basin and its unsuitability for aquatic life does not present a "major" stress to the BIP; (2) because of the characteristics of the benthic sediments, the regions currently affected by the salt wedge would still provide poor habitat even if dissolved oxygen levels were substantially increased; and (3) it is not even clear that the proposed diffuser actually would result in increased dissolved oxygen in the deep water pockets to levels that would inhibit the release of nutrients from the benthic sediments. Put simply, the problem upon which Mirant Kendall focuses (unsuitability of deep water pockets for habitat) affects a relatively small area; the problem probably would not be solved even if a diffuser fully oxygenated the deep water as Mirant Kendall speculates; and there is significant reason to doubt that the diffuser would do even that.

First, the salt wedge occupies a relatively small portion of the total volume of the Basin. Its dimensions change throughout the year based primarily on the number of boat lockages at the New Charles River Dam. As a result, the salt wedge reaches its maximum size during the summer when boat passage through the locks is highest. Conversely, the salt wedge is diminished or even absent during other times of the year when boat use declines and river flows are high or following large storm events (Breault et. al., 2000). Most importantly, even during worst case conditions, which are limited to the summer, the volume of water that typically has low dissolved oxygen due to the salt wedge is a relatively small portion of the lower Basin – approximately 15 percent of the total volume (Breault et al., 2000; EPA, 2001). This relatively small diminution in habitat does not appear to have a substantial adverse effect on aquatic life. In particular, there is no evidence that the salt wedge has interfered with the in- or out-migration of anadromous species.

Furthermore, while EPA acknowledges that significantly oxygenating the bottom waters typically affected by the salt wedge would make this relatively small volume of water accessible to finfish, EPA disagrees that such an improvement would constitute a “great” improvement in the overall habitat of the lower Basin, as Mirant Kendall claims. To the contrary, it is unlikely that destratification would result in a benthic habitat capable of supporting a healthy macroinvertebrate community that would provide a viable food source for finfish. First, the lower water column where the dissolved oxygen levels could be improved under complete mixed conditions would likely provide less suitable habitat than the upper water column because of the lack of light penetration and its impact on the ability for key fish species (e.g., river herring) to see food. Even more important, however, are the physical and chemical characteristics of the benthic sediments that lie under the salt wedge. These sediment deposits typically range in depth from 2 to 5 feet, are finely textured (made up of mostly silt and clay), and have a fluid or “soupy” composition (have low concentrations of total solids) (Breault et al., 2000). These sediments contain high levels of toxic contaminants (Breault et al., 2000) and were found to be toxic to amphipods and midges during toxicity testing conducted by EPA (EPA, 1997). Such sediments are not likely to support a viable and healthy macroinvertebrate community that would in turn provide sustainable food source for finfish. As a result of the degraded sediments, the value of the deep water habitat for resident species is marginal at best. Extensive sediment remediation, most likely involving dredging, would be necessary in order for the Agencies to consider the oxygenation of the deep water affected by the salt wedge to constitute a “great” improvement in habitat.

Finally, there is considerable uncertainty over exactly how much the proposed diffuser actually would raise dissolved oxygen levels in the bottom waters. Mirant Kendall has made an unsupported assumption that operation of the proposed diffuser would sufficiently raise dissolved oxygen levels in the lower water column typically affected by the salt wedge to levels that would support aquatic life uses consistent with Massachusetts’ Water Quality Standards. However, for reasons presented in Attachment A of the Draft Permit Fact Sheet (see page 28), Mirant Kendall’s dissolved oxygen model of the lower Basin is seriously flawed and unreliable for predicting post-diffuser dissolved oxygen levels.

4) Mirant Kendall inaccurately characterizes the following two points as EPA’s objectives with respect to the NPDES permit:

- maintenance of a thriving BIP, including river herring, which depend on restoring dissolved oxygen to the Basin and on a thriving algal community to provide the necessary food for the herring, and

- a desire to limit the extent of that very algal community.

One of EPA's primary objectives is to protect and propagate the BIP. However, EPA has not stated that protecting the BIP depends on restoring dissolved oxygen to the relatively small portion of the lower Basin (at most about 15 percent) that is typically affected by the salt wedge during the summer months. Restoring dissolved oxygen to the relatively small volume of bottom water for only a portion of the year is not essential for protecting the BIP. As noted in part 3 of this Response, the lower water column where the dissolved oxygen levels could be improved under complete mixed conditions is relatively small, and would likely provide less suitable habitat than the upper water column because of the lack of light penetration and the extremely limiting physical and chemical characteristics of the benthic sediments.

Mirant Kendall also mischaracterizes EPA's goals with respect to algae. The Draft Permit does not propose any conditions, including the proposal to not authorize use of the proposed diffuser, that aim to reduce algal biomass in the lower Basin. Rather, EPA's more modest objective with respect to algal biomass is to ensure that operation of the facility does not increase algal biomass and further contribute to excursions from applicable Massachusetts Water Quality Standards. This objective has been clearly stated in correspondence to Mirant Kendall (EPA July 9, 2001 letter) and at meetings with Mirant Kendall throughout the permit development process.

Comment related to E1 from CRWA: CRWA supported the EPA's decision to exclude the diffuser from the NPDES permit at this time. We feel that it is prudent for the regulators to wait until the basin model, being configured by Tetra Tech for the EPA, can be applied to evaluate use of the diffuser so that EPA can predict impacts related to eutrophication and algal blooms.
Comment related to E1 from Riverways: The argument put forward by the EPA against the installation of a diffuser is a sound one. It seems likely the facility would actually exacerbate poor water quality in the basin by increasing nutrient levels in the upper water column if diffusers were installed. The information and data provided offers a compelling argument that phosphorus limits growth during the later summer period, a period when recreational demands on the basin are at a peak, and diffusers would likely circulate nutrient laden bottom waters currently disinclined to mix with less dense, freshwater overlying waters.

Comment related to E1 from City of Cambridge: The City requests that the agencies revisit the proposed diffuser in the future, when information and modeling capabilities become available from the ongoing Charles River TMDL studies and that the permit provide for the installation of the diffuser should a future evaluation determine that the system would have a positive impact.

Comment related to E1 from Laura Donohue: If there is a bottom diffuser installed, it would need to be clearly marked. Water swirling around could create whirlpools, a potentially hazardous situation, especially for an unwitting single boat or inexperienced person.

Comment related to E1 from CLF: CLF supports EPA's decision to not include the diffuser in the permit at this time. Initial review of the proposed diffuser indicates that there are many unanswered questions about the effects the diffuser will have. There is the potential for serious negative effects due to dispersal of heated water, liberation of toxic materials from the bottom (e.g. metals), and mixing of nutrients from the deep parts of the Basin with oxygenated water. These impacts could decrease the availability of habitat for aquatic life in the lower Basin, and increase the frequency of algal blooms that reduce the value of the Basin as a recreational resource. The value of the diffuser to the permittee is clear, as it would allow the plant to discharge more heat while remaining within the temperature limits of the permit. However, the potential harm of a diffuser to the balanced indigenous population of fish, shellfish, and wildlife is too great to justify its use before studies are complete.

Response to Comments related to E1: EPA agrees that Mirant Kendall has failed to resolve the main issues of potential impacts associated with the proposed diffuser operation. The modeling of the diffuser and the evaluation of water quality and safety impacts is Mirant Kendall's responsibility and will not be conducted by EPA as part of the TMDL modeling work. EPA has informed Mirant Kendall that further evaluation of the diffuser by EPA will be contingent upon Mirant Kendall providing supporting information and a technical analysis specific to its proposed diffuser based on a credible linked hydrodynamic water quality model. See also Responses to C1, C3 and F1 through F6.

Comment E2: Mirant Kendall argues that, in denying Mirant Kendall's diffuser proposal, EPA has incorrectly applied the test of whether Mirant Kendall's proposed discharge has a "reasonable potential to cause, or contribute to an excursion above any State water quality standard," rather than the test of whether that discharge is "consistent with the protection and propagation of a BIP." Furthermore, Mirant Kendall suggests that EPA must ascertain whether Mirant Kendall's diffuser proposal "<u>in fact would</u> interfere with the protection and propagation of the BIP." (Emphasis added).

Response to E2: Mirant Kendall misapprehends both the applicable legal test and the burden of proof. As explained below, EPA is <u>not</u> denying Mirant Kendall's diffuser proposal solely based on concerns that the thermal component of the discharge from the diffuser would violate the Massachusetts water quality standards for temperature and/or interfere with the protection and propagation of a BIP. Rather, EPA is denying the diffuser proposal for reasons independent of concerns about the thermal component of the discharge. Under these circumstances, the procedure specified in CWA § 316(a) for a variance from otherwise applicable heat limitations does not control the question before EPA. Furthermore, both the statute and regulations make clear that EPA does not have the burden to demonstrate that the applicant's proposed discharge "in fact would" fail to meet the applicable legal test. Finally, even assuming that the CWA § 316(a) test controls the determination of whether to permit the diffuser, Mirant Kendall does not meet its burden.

<u>Applicable legal framework</u>

In evaluating the permit application and variance request as submitted by Mirant Kendall, EPA must set appropriate conditions not just for the permitted facility as a whole, but rather "for each outfall or discharge point of the permitted facility." 40 CFR § 122.45(a). The resulting permit must include requirements necessary to achieve water quality standards, including state narrative criteria such as the narrative aesthetic criteria impacted by algal blooms. See 40 CFR § 122.44 ("[E]ach NPDES permit shall include conditions meeting the following requirements when applicable . . . . (d) . . . . [A]ny requirements in addition to or more stringent than promulgated effluent limitations guidelines or standards . . . necessary to: (1) Achieve water quality standards established under section 303 of the CWA, including State narrative criteria for water quality.").

As an initial matter, Mirant Kendall misunderstands the applicable legal framework. Under the thermal variance procedure, an applicant may attempt to demonstrate "that any effluent limitation proposed for the control of the thermal component of any discharge from [the] source will require effluent limitations more stringent than necessary to assure the projection [sic] and propagation of a balanced, indigenous population of shellfish, fish, and wildlife." CWA § 316(a). If the applicant can demonstrate this, then the permitting agency "may impose an effluent limitation . . . with respect to the thermal component of such discharge (taking into account the interaction of such thermal component with other pollutants), that will assure the protection and propagation of a balanced, indigenous population." Id. Crucially, in each step the focus is on the thermal component of the discharge: the applicant must show that an effluent limitation "proposed for the control of the thermal component of [the] discharge" is more stringent than necessary to protect the BIP, and the permitting agency may then impose a less stringent effluent limitation "with respect to the thermal component of such discharge." Id. (emphases added).

However, § 316(a) analysis is not the only standard that applies to a discharge that may contain a thermal component. EPA's denial of Mirant Kendall's diffuser proposal is based on concerns that, independent of (although somewhat exacerbated by) the thermal component of the discharge, the physical force of the discharge water mixing the water column will distribute phosphorus into the upper water column. This concern is independent of the thermal component of the discharge, which can be illustrated in two ways. First, at least in principle, the same concern would apply if the discharge water were unheated. Second, EPA remains open to alternative design proposals that could discharge an equivalent amount of heat but might mitigate this concern.

Rather, EPA's denial of the diffuser proposal is based on EPA's independent obligation under CWA § 301(b)(1)(C) to ensure that its NPDES permit conditions satisfy all applicable state water quality requirements. Such conditions include, inter alia, the location of point sources such as an outfall or diffuser. EPA may thus deny a permit application, or issue a permit on terms different from those requested by the applicant, on the grounds that the discharge at the proposed discharge point would not satisfy the CWA. The appropriate standard for such an evaluation in this context is whether the proposed discharge of pollutants has "the reasonable potential to cause, or contribute to an excursion above any State water quality standard, including State narrative criteria for water quality." 40 CFR § 122.44(d)(1)(i) (emphasis added). That is precisely the standard that EPA applied. See Attachment A to Draft Permit Fact Sheet, page 34. Moreover, contrary to Mirant Kendall's comment, the relevant question is whether the proposed discharge presents a "reasonable potential" to cause or contribute to an excursion above a state water quality standard, not whether the discharge is "likely" to do so, let alone that it "in fact would" do so.

In summary, EPA has not denied the diffuser proposal on the grounds that it would contribute to excursions above the water quality standards for the thermal component of the discharge. Rather, EPA has denied the diffuser proposal on the grounds that the location and operation of the diffuser, independent of the thermal component of its discharge, presents a reasonable potential to cause or contribute to excursions above the eutrophication-related water quality standards. Under such circumstances, "protection and propagation of a balanced, indigenous population" under CWA § 316(a) is not the only applicable legal standard.

Although EPA has denied permission for the exact discharge requested by Mirant Kendall, EPA has, consistent with established practice, granted a permit with effluent limitations and other conditions different from those requested, rather than simply denying the application. In this context, EPA has in fact granted a CWA § 316(a) variance to allow Mirant Kendall to discharge heated water from its existing outfalls at temperatures that violate the Massachusetts water quality standards for temperature and ΔT. However, this does not mean that the CWA § 316(a) standard controls EPA's evaluation of the diffuser on eutrophication related grounds. Analytically, EPA has denied one proposal (the one submitted by Mirant Kendall) and granted another (one not submitted by Mirant Kendall but which complies with the requirements of the CWA). The fact that § 316(a) applies to one does not mean it controls the determination of the other.

That said, because much of the BIP analysis had to be conducted in this context anyway, and out of an abundance of caution, EPA has also analyzed Mirant Kendall's diffuser proposal as if CWA § 316(a) and its implementing regulations defined the applicable legal framework. In so doing, EPA emphasizes that CWA § 316(a) does not provide the applicable framework for the eutrophication related water quality standards, and that EPA provides the following analysis only by way of explaining why EPA's decision to deny the diffuser proposal does not turn on this legal question.

Alternative analysis under CWA § 316(a)

Even under the less stringent "protection and propagation of a balanced, indigenous population" standard, EPA would deny the diffuser proposal because Mirant Kendall has not met its burden. To receive a CWA § 316(a) variance, an applicant must make two distinct demonstrations. First, the applicant must "demonstrate to the satisfaction of the Administrator" that technology or water quality based limitations on the diffuser's discharge are more stringent than necessary to assure the protection and propagation of a BIP. Id.; see also 40 CFR § 125.73(a) (thermal variance available "if the discharger demonstrates to the satisfaction of the director" that limitations are more stringent than necessary). Second, the applicant "must show that the alternative effluent limitation desired by the discharger, considering the cumulative impact of its thermal discharge together with all other significant impacts on the species affected, will assure the protection and propagation of a [BIP]." 40 CFR § 125.73(a). As explained in the

Determination Document, the applicant's burden is "stringent." Draft Permit Determination Document § 4.2.3, pages 33-36.

As described above, Mirant Kendall did not meet this burden because it neither produced credible predictive studies nor demonstrated, pursuant to 40 CFR § 125.73(c)(1), an "absence of prior appreciable harm" from its existing outfalls. (In fact, the "absence of prior appreciable harm" test is inappropriate for the diffuser proposal because the diffuser would be a new type of discharge, and the attendant environmental concerns turn largely on precisely those facts – its location and the vertical momentum of its discharge – that make it new. However, out of an abundance of caution, EPA has considered the information that Mirant Kendall submitted as if the "absence of prior appreciable harm" test were applicable, and still finds it insufficient with respect to eutrophication. See also Responses to B1, B2, B3, C1 and C3.)

Specifically, EPA expressed concerns that operation of the proposed diffuser would increase circulation of phosphorus through the water column, and that this in turn would increase algal blooms – particularly of noxious blue-green algae that tend to displace other, less objectionable species some of which contribute to the food web that supports fish such as river herring. Of course, the legal burden of a CWA § 316(a) demonstration lies entirely on the applicant – the statute, regulations, and cases make that clear. That said, it is worth noting that EPA's concerns, as documented in Attachment A to the Draft Permit, constitute a "prima facie case" that the limits contained in Mirant Kendall's diffuser proposal would <u>not</u> assure the protection and propagation of a BIP.

Moreover, contrary to Mirant Kendall's comment, it is not <u>EPA's</u> burden to show that the proposed discharge "<u>in fact would interfere with</u> the protection and propagation of the BIP." Rather, it is <u>Mirant Kendall's</u> burden to demonstrate that the proposed discharge, operating under effluent limitations that would violate water quality standards, "<u>will assure</u> the protection and propagation of a [BIP]." 40 CFR § 125.73(a) (emphasis added). Mirant Kendall has not made such a demonstration. Quite the contrary; its data are questionable and its models are flawed and/or unvalidated, and consequently EPA has little or no confidence in Mirant Kendall's analyses. Accordingly, even under the less stringent test of CWA § 316(a), EPA would deny the diffuser proposal.

Comment E3: Mirant Kendall argues that it initially proposed a eutrophication monitoring program so that the diffuser could be started up, monitored and operationally proven or restricted as appropriate. The draft permit denies the diffuser proposal but requires a costly monitoring program. Mirant Kendall argues that it would be arbitrary and capricious for EPA to impose the eutrophication monitoring program unless it also approves the proposed diffuser.

Response to E3: The basis for including the monitoring requirements is independent of concerns associated with the proposed diffuser. Because the permit allows Kendall Station to discharge thermal loads through its existing outfall at levels that are far above levels that have been discharged when algal-related water quality impairments existed in the Basin, and because Mirant Kendall has not submitted a credible demonstration of the impact of its potential thermal discharge nor responded to EPA's repeated requests to provide such a demonstration, EPA has required a eutrophication-related monitoring program in the Draft Permit. The purpose of the monitoring program is to provide the water quality data and information necessary for EPA to assess the impacts of the increased thermal load associated with the operation of the upgraded facility on algal biomass and community structure in the lower Basin. Published scientific research involving controlled studies has convincingly shown that algal growth rates increase with increasing temperature. See Attachment A to the Draft Permit Fact Sheet, pages 17-18. The monitoring requirements are necessary to track algal growth under different operating conditions at the plant during the critical summer/early fall period when high thermal loading conditions from the facility have the greatest potential to exacerbate existing water quality impairments in the lower Basin.

Mirant Kendall's statement that the monitoring program was developed "partly because, as EPA has found in their TMDL modeling, it is not readily feasible to develop a fully certain model of the diffuser's effects in this very complex water body" is incorrect. EPA has never made such a statement. EPA continues to believe that it is feasible to develop a representative and credible model that can be used to simulate the operation of the diffuser and its potential impacts on water quality and has requested that Mirant Kendall prepare such a model to support its diffuser proposal. As discussed in responses A12, A13, E1 and E23, EPA has not modeled, and does not view it as EPA's responsibility to model, Mirant Kendall's proposed diffuser and its impacts. As a general principle, EPA does not use public resources to provide modeling services for private NPDES permit applicants seeking to introduce new point sources with unknown hydrodynamic effects. Mirant Kendall has the responsibility of modeling its own proposal, and such modeling is certainly beyond the scope of the TMDL project because that project aims to model the river system as it is now.

Even though Mirant Kendall has failed to provide a credible water quality model, EPA has not relied solely on existing water quality data to show that Mirant Kendall's existing thermal discharge is causing or contributing to eutrophication-related water quality impairments in the lower Basin. There are too many factors, several of which vary within the Basin, that are important to algal growth (e.g., temperature, water clarity, nutrient availability, light intensity, sedimentation rates) and which make it virtually impossible to isolate temperature as the sole influencing factor on algal growth. See Attachment A to the Draft Permit Fact Sheet, page 19. Therefore EPA has been careful not to draw conclusions based solely on available data. Rather, EPA has focused on well-established and generally applicable scientific research that is consistent with the data that are, in fact, available.

Under the circumstances described in the Introduction to Section E and the Responses to E1 and E2, it would be inappropriate to authorize the operation of the proposed diffuser without credible supporting information, including a detailed water quality analysis that considers pertinent chemical and biological processes specific to the operation of the proposed diffuser. Mirant Kendall has declined to submit such an analysis to EPA and has instead relied on the presumption that destratification of the lower Basin, regardless of how it is accomplished, would result in the deeper part of the water column becoming well oxygenated. EPA disagrees with the basis of this presumption. The Army Corp of Engineers reviewed projects where oxygenation techniques were used to oxygenate the hypoliminions of stratified waters and to reduce algal blooms (ENSR, 2004). The results of this review indicated that water quality conditions were made worse in approximately half of the projects and that the greatest risk from artificial circulation involves transport of nutrients and other substances from the bottom to the surface of the waterbody. Furthermore, temperature increases in the bottom waters, as would occur with operation of the diffuser, may counteract the redox reactions that bind phosphorus in the benthic sediments and stimulate decomposition rates and phosphorus release (EPA, 1990). EPA's 1990 guidance document, *The Lake and Reservoir Restoration Guidance Manual*, gave artificial circulation practices a "poor" confidence ranking for addressing eutrophication.

It appears that Mirant Kendall's primary objective in the design of the proposed diffuser was to distribute the thermal discharge more broadly throughout the lower Basin. While this goal is laudable in isolation, the complexities of the lower Basin require EPA to consider other objectives, particularly the prevention of additional excursions from state water quality standards. Mirant Kendall has not adequately addressed the identified water quality impacts. Mirant Kendall did not develop a credible water quality model to evaluate water quality impacts associated with the proposed diffuser, and did not evaluate alternative diffuser system designs with the goal of minimizing potential eutrophication-related water quality impacts. Because of the potential negative impacts associated with Mirant Kendall's diffuser proposal, a credible water quality model is required to identify the characteristics of diffuser designs that would be protective of water quality in the lower Basin.

In summary, EPA is not authorizing operation of the proposed diffuser in the Final Permit because (1) there is a reasonable potential that operation of the proposed diffuser would result in degradation of surface water quality in the lower Basin; (2) Mirant Kendall has not provided the necessary supporting information and water quality analysis to show that the operation of the proposed diffuser will not increase algal biomass in the lower Basin; and (3) Mirant Kendall has not evaluated design alternatives to identify the characteristics of diffuser designs that would minimize eutrophication-related water quality impacts of the diffuser. To the contrary, Mirant Kendall's monitoring and contingency proposal would clearly allow for further degradation of the lower Basin which would be inconsistent with attaining Massachusetts Water Quality Standards. See Attachment A to the Draft Permit Fact Sheet, page 31. In any event, EPA will only consider a monitoring/contingency proposal as the means for justifying authorization of a diffuser after Mirant Kendall has performed, to EPA's satisfaction, the diffuser water quality modeling and design analyses discussed above.

Comment related to E3 by Roger Frymire: The (proposed) diffuser appears to have been postponed because it may be prone to release more nutrients to go along with the higher temperatures that are already expected, and further exacerbate the algae blooms. I believe the diffuser needs to be built and the amount of monitoring should be used to closely monitor temperature and biological parameters and make sure that a new regime was reached that is stable again and isn't releasing a constant stream of nutrients.

Response to Comment related to E3 by Roger Frymire: See Introduction to Section E and Response to E3 above for reasons for EPA deciding to deny the diffuser proposal at this time even with close monitoring. .

Comment related to E3 from MA CZM: MA CZM suggests that the list of constituents analyzed for in the grab sample program outlined in Section I.A.14.d.2 be expanded to include all chemicals known to occur in the sediments of the Charles River basin and are therefore likely to be present in the water column under certain meteorological or operational conditions that might resuspend sediments.

Response to Comment related to E3 from MA CZM: EPA is not aware of conditions associated with operation of the facility, other than the rejected diffuser proposal, that would result in the resuspension of benthic sediments. Therefore, it is unnecessary to include such monitoring requirements at this time.

Comment E4: Mirant Kendall argues that EPA has not adequately considered the benefits of restoration of dissolved oxygen to the deeper layers of the Basin, particularly with respect to how reduction of stratification by the diffuser could affect and improve the available habitat for yellow perch, alewives and other species comprising the BIP.

Response to E4: EPA has fully considered the potential benefits and drawbacks of the proposed outfall diffuser, as explained in the Draft Permit and Fact Sheet. Mirant Kendall has overstated the potential benefits that might result from operation of the proposed diffuser and has not considered other factors such as increased temperature, salinity, poor visibility and sediment characteristics that would limit the value of this habitat even if dissolved oxygen was improved. See Response to E1, part 3. At this time, Mirant Kendall has not met its burden of establishing that the benefits of this discharge will outweigh the drawbacks. Before authorizing such a discharge, EPA will require a detailed analysis of the proposed diffuser and its potential impacts in order to ensure that (1) water quality will not be degraded and (2) the diffuser system is designed to minimize water quality impacts.

However, Mirant Kendall has provided neither the necessary documentation, nor a credible water quality model, to support its assertions that the benefits associated with the operation of the proposed diffuser will likely occur, or to what extent they might occur. EPA has not received credible evidence that dissolved oxygen levels along the bottom of the river and in the deep water pockets would increase to levels that will fully support aquatic life uses or be sufficient to prevent the release of nutrients from the bottom sediments. See Introduction to Section E; see also Attachment A to the Draft Permit Fact Sheet, pages 19-28. Moreover, even if dissolved oxygen is significantly increased, the chemical and physical characteristics of the sediments in the lower Basin, particularly in the deeper areas of the Basin where the salt wedge usually exists, are extremely limited with respect to supporting a healthy and viable macroinvertebrate community. See Response to E1, part 3.

Comment E5: Mirant Kendall quotes Section 5.1 of the Determination Document, in which EPA states that "[i]t is important to note here that EPA and others in the last decade have made steady progress in improving Charles River water quality and habitat for aquatic organisms." Mirant Kendall then states that "the habitat for aquatic organisms in the lower Charles River actually has declined in recent years because prolonged and increasing stratification has made benthic habitat less suitable for species such as the Agencies' target resident species, yellow perch, that prefer such habitat." Mirant Kendall argues that EPA has not fully considered the potential benefits of the diffuser with respect to destratification.

Response to E5: See responses to E1, part 3, and E4. There has, in fact, been steady progress in improving the water quality of the Basin during the last decade. However, the primary improvements that EPA referred to in Section 5.1 of the Determination Document were elimination and reduction of untreated sanitary sewage discharges to the Basin.

The reduction in bacteria sources has resulted in an increase in the frequency and duration that indicator bacteria concentrations in the Basin are in attainment with MA Water Quality Criteria. As a result of these improvements, the Basin, and particularly the lower Basin is able to support designated primary and secondary contact recreational uses more often. EPA is not aware of significant documented improvements in the habitat of the lower Basin during the recent past.

Moreover, EPA disagrees with Mirant Kendall's assertion that habitat has declined "in recent years" due to stratification. As explained below, the habitat decline in the Basin is not "recent," and is largely due to factors other than stratification.

Salt water intrusion into the Basin (and the resulting stratification and depletion of dissolved oxygen in the lower water column of the lower Basin) is not a recent phenomenon or one that has been increasing in severity each year. Salt water intrusion has been occurring in the Basin since 1908, when the Old Charles River Dam was built next to the Museum of Science, and has continued even after the construction of the new Charles River Dam in 1979 (Breault et al., 2000; MDC, 1981). The more recent intensive data collection efforts conducted by the USGS, EPA, and Mirant Kendall that document the presence and extent of the salt wedge began in 1998. It should be noted that the Basin was essentially flushed out of salt by two very large storm events during the summer of 1998, which could partially explain the apparent increasing trend from early 1999 and early 2000 shown in Figure D-9. Also, information for several winter, spring and fall months are notably absent in Figure D-9. Typically, based on the USGS observations, the salt wedge is diminished during these months. Earlier water quality data from the lower Basin collected by the EPA (1997) and the MWRA (1997) show elevated salinity levels of similar magnitude as well. The information presented in Figure D-9 fails to support Mirant Kendall's position that the magnitude of salt water intrusion is increasing each year. To evaluate whether any trends exist concerning salt water intrusion, EPA would need calculations of total salt mass in the lower Basin and salinity and dissolved oxygen data from earlier years (1982-1997).

Regardless of salt water intrusion into the Basin, the benthic habitat in the lower Basin is severely degraded because of contaminated sediments which have been accumulating nearly 100 years in the lower Basin since construction of the Old Charles River Dam (Breault et al., 2000). During the past century, urban runoff, atmospheric deposition, inadvertent spills, combined sewer overflows, and illegal sewage connections have contributed to the Basin fine-grained sediments and both inorganic and organic compounds. These contaminants have degraded the quality of the water, biota, and sediment (Breault et al., 2000). Furthermore, inorganic elements and organic compounds are present at sufficiently high concentrations at many surficial-sediment sampling sites to cause potentially severe biological effects to benthic organisms living in and on the bottom sediment (Breault et al., 2000). For example, in 1997 EPA performed toxicity tests on the sediments of the lower Basin and found them to be toxic to amphipods and midges (EPA, 1997).

Mirant Kendall has not provided adequate evidence to support its statements concerning the benefits of the proposed diffuser nor to show that the operation of the proposed diffuser would not degrade the surface water quality and increase the severity of use impairments in the lower Basin. See Introduction to Section E and Response to E1. Many millions of dollars have been spent to eliminate CSOs and illicit sewage discharges in order to reduce bacteria sources and increase the frequency that recreational uses are supported in the Basin. Based on the information submitted by Mirant Kendall, EPA is not persuaded that possible benefits of the diffuser outweigh potential water quality problems that could occur from the operation of the diffuser. EPA must be persuaded that the operation of the proposed diffuser will not reverse the trend of improving water quality and increased support for recreational uses, which have come at great cost to the communities in the greater Boston area. Furthermore, Mirant Kendall has failed to demonstrate that the proposed diffuser is designed to minimize potential water quality problems. As EPA has repeatedly informed Mirant Kendall, a credible modeling analysis is necessary to determine whether a diffuser is appropriate for the lower Basin.

Comment E6: Mirant Kendall argues that EPA's efforts to limit overall algal growth could adversely affect river herring, which depend directly on algal production to create their food base. Mirant Kendall requests that EPA determine the minimum amount of algae necessary to support the river herring BIP in the Charles. Finally, Mirant Kendall urges EPA to find that a chlorophyll *a* level up to 45 µg/l would be acceptable.

Response to E6: EPA has considered the information submitted by Mirant Kendall concerning algal levels and river herring. However, as the Draft Permit does not propose any limits or conditions that would expressly <u>reduce</u> algal biomass in the lower Basin, this issue is not relevant to this permit. EPA has emphasized to Mirant Kendall throughout the permitting process that the goal of all eutrophication-related conditions considered and proposed in the Draft Permit was to prevent the operation of the facility from <u>increasing</u> algal biomass and making existing water quality impairments worse in the lower Basin. See Response to E1, part 4. This goal is the reason for EPA's decision to deny the diffuser proposal.

Mirant Kendall appears to suggest that the potential for the operation of the proposed diffuser to increase algal biomass in the lower Basin should not concern EPA because increased algal biomass will contribute to the food base for herring. Mirant Kendall has incorrectly assumed that increases in algal biomass above current typical levels will result in a proportional increase to the food base for herring. In natural systems, phytoplankton food composition usually does not remain the same as phytoplankton biomass increases to high levels. Harmful blue-green species (poor food quality) tend to increase in predominance as chlorophyll *a* concentrations increase, while the fraction of diatoms and other taxa (good food quality) decrease (USEPA, 2003). Furthermore, Mirant Kendall suggests that EPA allow an average summer chlorophyll *a* concentration of 45 µg/l. Based on data collected by the EPA, this value represents approximately <u>twice</u> the summer chlorophyll *a* averages observed in the lower Basin for summers of 1998 to 2004 which ranged from 15.1 µg/l (1998) to 27.4 µg/l (1999). Thus, Mirant Kendall appears to be suggesting that it should be permissible for the operation of the diffuser to <u>double</u> the amount of algal biomass in the lower Basin causing hypereutrophic conditions (USEPA, 1990) and making existing eutrophication-related impairments far worse.

Mirant Kendall asserts that the peak abundance of both larval and juvenile stages of river herring observed in 1999, followed by the greatest returning year-class strength 2000, is correlated to EPA's reported highest average chlorophyll *a* concentration (1999) shown in Table 1 of Attachment A. This assertion is speculative and not supported by a more thorough review of the chlorophyll *a* data. First, the chlorophyll *a* data reported in Table 1 of Attachment A have not been corrected for pheophytons. Also, the 1999 chlorophyll *a* data set are log-normally distributed. For log-normal distributions, the median is a better statistical indicator of central tendency than the average as it is less affected by extreme high values. As indicated in Tables 1-3 of Response E1, the EPA median chlorophyll *a* (corrected for pheophytons) values for 2000 (26.7 µg/l), 2001 (25.4 µg/l), 2002 (16.4 µg/l), 2003 (19.4 µg/l), and 2004 (26.6 µg/l) are all higher than the EPA median value for 1999 (16.1 µg/l). The statistics for the MWRA chlorophyll *a* data (corrected for pheophytons) presented in Table E1-4 of Response to E1, which represent data from many more sampling events than the EPA data, show similar results with the median chlorophyll *a* values for 1997 (37.8 µg/l), 2000 (19.9 µg/l), 2001 (26.8 µg/l), 2002 (20.5 µg/l), and 2003 (21.8 µg/l) all being higher than the median value for 1999 (19.2 µg/l). These data do not indicate that overall algal biomass in the lower Basin was higher during the growing season of 1999 than in other years. The apparent higher numbers of larvae and juvenile river herring in 1999 and the returning-year class in 2000 may be a function of other factors.

The Charles River Basin is currently not supporting designated uses specified in Massachusetts Water Quality Standards because excessive algae have led to violations of several criteria. See Attachment A to the Draft Permit Fact Sheet, pages 2-3, 13-15. Increasing algal biomass in the lower Basin will increase the severity of these impairments which are already preventing the full support of designated uses in the lower Basin. Also, increasing phytoplankton biomass beyond existing levels will not necessarily increase the food base but will likely increase the fraction of harmful species (e.g., blue-greens) that have little to no food value. EPA is unaware of any evidence that shows that the herring populations in the Basin are limited because of the lack of food or that increases in phytoplankton biomass beyond existing levels would add more food. Consequently, the benefits (if any) of increased algae to the herring population are outweighed by the disadvantages of aggravating existing violations of water quality standards.

Comment E7: Mirant Kendall argues that EPA failed to consider the potential benefits of the proposed diffuser insofar as it might improve habitat for benthic macroinvertebrates, particularly at intermediate depths of periodic oxygen depletion.

Response to E7: EPA has fully considered the potential benefits and drawbacks of the proposed diffuser and has determined, based on available information presented in Attachment A to the Draft Permit Fact Sheet (see pages 20-31), that the potential negative water quality impacts (i.e., increased algal biomass) associated with the proposed diffuser outweigh the undefined potential benefits.

Mirant Kendall has not provided adequate evidence to support its presumption that the operation of the proposed diffuser would add structure and improve habitat for benthic macroinvertebrates. First, considerable uncertainty remains regarding how much the proposed diffuser would increase dissolved oxygen (DO) levels in the lower water column, and whether improvement would be seen at the sediment/water interface in particular. See Attachment A to the Draft Permit Fact Sheet, page 29; Response to E1, part 3. Second, Mirant Kendall has failed to consider the extremely limiting physical and chemical characteristics of the benthic sediments that lie under the deep water pockets where the salt wedge typically exists. As discussed in the responses to E1 and E4, these sediment deposits typically range in depth from 2 to 5 feet, are finely textured (made up of mostly silt and clay), and have a fluid or “soupy” composition due to low concentrations of total solids (Breault, et al., 2000). Additionally, the sediments contain high levels of toxic contaminants (Breault et al., 2000) and were found to be toxic to amphipods and midges during toxicity testing conducted by EPA (EPA, 1997). Such sediments are not likely to provide the necessary structure or chemical environment to support a viable and healthy macroinvertebrate community that would in turn provide a sustainable and healthy food source for finfish.

Comment E8: Mirant Kendall argues that the proposed diffuser would restore dissolved oxygen to the lower water column and that this could significantly enhance populations of at least two preferred benthic prey items: larval sphaerid clams and larval chironomids.

Response to E8: See Response to E7.

Comment E9: Mirant Kendall notes that Section 5.4.9 of the Determination Document states: “This dense wedge of salt water…usually is low in dissolved oxygen.” Mirant Kendall states that the entering salt water is usually high in dissolved oxygen, and only becomes oxygen-depleted after some time in the basin. Mirant Kendall argues that EPA should consider the proposed diffuser’s potential to mitigate the problem by not allowing stratification to remain in place long enough for the depletion to occur.

Response to E9: EPA concurs with Mirant Kendall's observation that the incoming salt water to the Basin from Boston Harbor is well oxygenated and becomes oxygen-depleted only after time in the Basin. With respect to the claim that the operation of the proposed diffuser will mitigate low DO levels that occur in the lower water column, see Response to E7.

Comment E10: Mirant Kendall argues that EPA has underestimated the extent of the "habitat squeeze" between surface water of unsuitable temperature and bottom water devoid of oxygen. Mirant Kendall asserts that, in addition to the warm weather "temperature/oxygen squeeze" described in Section 5.4.10 of the Decision Document, habitat is squeezed for species like yellow perch when bottom salinities become too high even when enough oxygen is present. Mirant Kendall suggests that this cold weather "squeeze" in this basin may be even more limiting, because, unlike the summer situation, the fish may literally have nowhere to go to avoid it. Mirant Kendall argues that EPA should consider the potential benefits of the proposed diffuser's mixing and the elevated temperature of the discharge with respect to both dimensions of this winter "squeeze."

Response to E10: EPA has not underestimated the extent of the habitat squeeze. It is important to clarify that the upper boundary of the habitat squeeze is due to elevated temperatures caused at least in part by Mirant Kendall's thermal discharge. EPA acknowledges that use of an outfall diffuser would likely reduce the habitat squeeze caused in part by Kendall Station's discharge, but have not stated, as implied in Mirant Kendall's comment that the proposed diffuser would "significantly" mitigate this squeeze. The critical question facing EPA is to what degree the habitat squeeze would be reduced and whether the other potential benefits would outweigh the potential negative consequences of diffuser use. Based on available information presented in Attachment A to the Draft Permit Fact Sheet (see pages 20-31) and discussed in EPA's responses, EPA has found that the potential negative water quality impacts (i.e., increased algal biomass) associated with the proposed diffuser outweigh the potential benefits. Moreover, before authorizing discharge from a proposed diffuser in the future, EPA will require Mirant Kendall to conduct a detailed analysis of the diffuser and its potential impacts to ensure that water quality will not be degraded. See Response to E4.

Comment E11: Mirant Kendall argues that EPA has failed to consider the potential benefits of the proposed diffuser with regard to increasing the assimilative capacity of the Basin to distribute heat (from any source, not just Kendall Station's discharge), thus reducing the maximum exposure temperatures experienced in the Basin.

Response to E11: EPA acknowledges that the proposed diffuser would probably increase the thermal assimilative capacity of the lower Basin. However, this is not a significant environmental benefit. The primary sources of heat in the Basin are Kendall Station's discharge and the sun. EPA is unaware of any other significant heat sources that could take advantage of an increased thermal assimilative capacity. Furthermore, Mirant Kendall has not presented evidence that other heat sources to the Basin (i.e., excluding Mirant Kendall's thermal discharge to the lower Basin), are sufficient to cause non-attainment of Massachusetts temperature standards or temperature-related aquatic life impairments in the lower Basin. To the contrary, the primary (or perhaps even sole) beneficiary of increasing the thermal assimilative capacity of the Basin is Mirant Kendall itself, by allowing the facility to discharge a greater amount of thermal load while still meeting the proposed temperature limits. Nevertheless, EPA has considered this benefit to Mirant Kendall in its decision not to authorize the proposed diffuser in this permit.

Comment E12: Mirant Kendall argues that the proposed diffuser would improve conditions for yellow perch.

Response to E12: See responses to E1 through E11, especially E7 and E23.

Comment E13: Mirant Kendall asserts that EPA has misattributed wide swings in DO in the Basin to algal blooms. Mirant Kendall argues that the oxygen deficit in the ZPH has nothing to do with algal blooms. Rather, Mirant Kendall insists, stratification above sediments high in oxygen demand is the "long acknowledged" cause of the oxygen deficit in the ZPH.

Response to E13: Mirant Kendall's analysis is incorrect. Evidence that the algae in the Basin are excessive includes, but is not limited to, diurnal DO swings and supersaturated DO levels observed in the Basin. Typically, surface water DO concentrations are directly proportional to the partial pressure of oxygen in the atmosphere. However, during photosynthesis, algae use energy from sunlight and dissolved carbon dioxide from the water to create cell mass. A byproduct of this process is oxygen. The pure oxygen being released from the algal cell causes DO concentration in the surrounding water to rise as a result of the higher partial pressure of DO (Thomann, 1987). High levels of DO supersaturation in waters are of concern because they can contribute to gas bubble disease in fish (EPA, 1986). In the Basin, DO data collected during the summer period when chlorophyll *a* levels were elevated reveal that the upper water column was frequently supersaturated with DO during the daylight hours (EPA data 1998-2004).

While algae produce oxygen through photosynthesis during the daylight hours, algae also consume DO through respiration. Usually, the minimum DO concentration occurs in the early morning hours after the algae have respired throughout the night and prior to the onset of photosynthesis. In some cases, the minimum DO will drop below a critical threshold or criterion value that would not be protective of aquatic life. In the Basin, diurnal DO variations typically range between 1 and 5 mg/l (EPA 1998-2004). Fortunately, the minimum DO concentrations in the upper water column appear to rarely drop below the Massachusetts minimum DO criterion of 5.0 mg/l set for the Charles River Basin. However, diurnal DO variations of this magnitude are indicative of excessive productivity from algae (i.e., eutrophic conditions).

Although the Basin experiences very high (supersaturated) concentrations of DO in the upper water column, it also has very low DO concentrations (0 to 3 mg/l) in the lower layer of the water column when the lower Basin becomes stratified. However, it is not uncommon for eutrophic waters that stratify to have low DO in the hypolimnion (bottom layer) because of the lack of exchange with the atmosphere, algal respiration, and the decomposition of the increased organic load from dead algae. EPA agrees that stratification in the lower Basin is caused primarily by salt water intrusion and that high DO demand is associated with the sediments. Algal respiration, and particularly the decomposition of the organic load associated with the settled algae, are important factors that contribute to the low DO in the lower water column of the lower Basin. This analysis is supported by the sediment data collected by the USGS from the Basin which found the sediments to have a high organic content (Breault, 2000, AR#151; Breault, 2003, AR#387).

Mirant Kendall cites purportedly contrary data from the Hudson River system. However, the study of algal respiration in the Hudson River system is not directly relevant to the Charles River Basin. The relative importance of factors affecting DO in a water is typically very site-specific. For example, the segment of the Hudson River referred to in the paper submitted by Mirant Kendall is a much larger river system that is affected by tidal action and is considered to have low primary productivity (Howarth, et. al., 1992). Clearly, as indicated by the chlorophyll *a* data and the eutrophic status of the Charles River Basin (see Attachment A to the Permit Fact Sheet), the Basin cannot be considered to have low primary productivity during the growing season. Furthermore, in a system that experiences low DO and does not attain DO criteria, EPA considers any component (including algal respiration) that constitutes 25% of the total DO demand to be a significant component of DO demand.

Mirant Kendall's comment that the proposed diffuser would destratify the area and restore oxygen to the lower water column, as did the MDC aerators 4 and 5 when they were operational, is unsupported. Mirant Kendall has not provided the necessary supporting analysis to show how the diffuser would likely affect DO in the lower water column. Moreover, Mirant Kendall has not demonstrated that the proposed diffuser would have the same effects on the lower water column as did the MDC aerators. See Responses to E1, E7, E16; Attachment A to the Draft Permit Fact Sheet, pp. 21-24, 28-29.

Comment E14: Mirant Kendall argues that, even if the operation of its proposed diffuser would increase the levels of phosphorus above the pycnocline, this would not increase the potential for algal growth. Mirant Kendall asserts the following three major points: (1) algae in the lower Basin are not phosphorus-limited, (2) EPA's own data indicate that river flows, which lead to extended residence times that allow algae to proliferate before being washed out of the system, are by far the most important factor in algal growth in the lower Charles and are a much more likely and plausible explanation for the rise in chlorophyll levels than phosphorus fluctuations; and (3) the elevated chlorophyll a levels shown in EPA's data are "not . . . particularly high."

Response to E14: For reasons presented in Attachment A of the Fact Sheet and summarized below, phosphorus limits algal growth during portions of the summer period when algal blooms are typically most severe in the lower Basin.

Algal growth is primarily a function of nutrient availability, light, and temperature (Chapra, 1997). Of all the nutrients that are needed by algae (i.e., carbon, oxygen, nitrogen, phosphorus, silica, sulfur, and iron), phosphorus and nitrogen are typically in limited supply. The relative amounts of phosphorus and nitrogen in aquatic systems determine which of these nutrients are in more limited supply for algal growth. Depending on the time of year and other environmental factors (i.e., water clarity, temperature and flushing rate), either phosphorus or nitrogen may limit algal growth.

In the Basin, based on measured amounts of nitrogen and phosphorus, phosphorus is the more limiting nutrient for algal growth. A typical ratio of nitrogen to phosphorus in algae is 7.2:1 (Chapra, 1997). Thus, TN:TP ratios less than 7.2 typically indicate nitrogen limitation while TN:TP ratios greater than 7.2 indicate phosphorus limitation (Chapra, 1997). An analysis of paired TP and TN data collected at MWRA station 166 (July - October, 1998 - 2004) found that mass TN to TP ratios ranged from 7.8 to 26.0 with a mean and median of 14.0 and 13.8, respectively.

Although phosphorus appears to be more limiting than nitrogen, other water quality data from the Basin indicate that algal growth may be limited by other factors during the early summer period. Typically, during June and early July, chlorophyll *a* concentrations are often low while corresponding TP and orthophosphate concentrations are elevated at levels that would otherwise typically indicate excessive algal growth. During this time, it is likely that algal levels are limited by other factors, such as light attenuation, consumption by zooplankton, hydraulic residence time, and/or water temperature. Orthophosphate concentrations in the Basin are an indicator of whether phosphorus is limiting algal growth at the time of the sampling because it is the form of phosphorus that algae use for growth. If algae levels are low but orthophosphate levels are high, it is likely that other factors are controlling algal levels. Conversely, during the mid to late summer, when conditions are typically more favorable for algae growth in the Basin, algae levels are typically elevated and orthophosphate concentrations are low, usually below detection, indicating that phosphorus is in demand.

During the early summer, water in the Charles River is highly colored or “stained” by dissolved organic matter. The presence of dissolved organic matter and color in the Charles River reduces light transmission through the water column and thus impedes algal growth. A likely source of the color (staining) is the dissolved organic matter from decaying vegetation from the extensive wetland areas adjacent to the river in the upper watershed. As the summer progresses, watershed contributions of flow and pollutants (including nutrients and dissolved organic matter) to the Charles River decline, resulting in improved water clarity and reduced nutrient levels in the Basin. Consequently, phosphorus, rather than light and possibly hydraulic residence time, typically becomes the limiting factor on algal growth during the mid to late summer period.

Usually the most severe algal blooms occur in late July, August and September when environmental conditions are most favorable for algal growth (i.e., higher water temperatures, improved water clarity, and longer hydraulic residence times). Under these conditions, available water quality data supports the contention that phosphorus availability limits algal growth. The increase in bloom severity coincides with declines in water color (increased water clarity) and increases in water temperatures. Decreases in TP and increases in bloom severity also coincide with declines in river flow, which increases the water residence time in the lower Basin and allows for more time for algae to grow and accumulate in the Basin. Seasonal reduction in TP and water color are likely due to reductions in flow and pollutant load contributions from the watershed.

Figure 2 from Attachment A of the Fact Sheet presents the seasonal trend of several water parameters and river flow observed in the lower Basin during the sampling season in 2002. The seasonal trends depicted for the summer of 2002 are generally consistent with seasonal trends observed for the same parameters during the other years that EPA has monitored the Basin (1998-2004). As indicated, true color (a measure of color caused by dissolved compounds), TP, and orthophosphate are higher while chlorophyll *a* is lower during the early summer period. As the summer progresses, true color, TP, and river flow decline and chlorophyll *a* increases markedly. Figure 2 also illustrates the portion of the summer when phosphorus becomes the limiting factor to algae growth in the lower Basin. As the summer progresses, orthophosphate concentrations typically fall below the analytical detection level used by EPA (5-8 ug/l), indicating that algae were readily consuming available phosphorus. This pattern of orthophosphate dropping below the minimum detection limit during mid to late summer when algae blooms are typically most severe has occurred in every year (1998-2004) that EPA has monitored the Basin.

Mirant Kendall mischaracterizes a statement on page 29 of Attachment A to the Fact Sheet concerning levels of phosphorus that are likely to limit algal growth. The statement in question reads in full: "In general, when TP concentrations are less than 0.05 mg/l phosphorus is likely to be controlling growth; between 0.06 and 0.08 mg/l phosphorus might be controlling growth; and above 0.1 mg/l, phosphorus is not likely to be limiting algal growth (Wagner, 2003)." This statement was provided to show that the phosphorus levels that typically occur in the lower Basin during mid to late summer period are at levels that could control algal growth. Mirant Kendall, however, selectively quotes the statement and claims in comment E14 that "the Agencies' [sic] acknowledge at p.29 that phosphorus 'is likely to be controlling growth' only when phosphorus levels are less than 0.05 mg/l," implying (contrary to the rest of the quoted sentence) that levels above 0.05 mg/l are of no concern.

As discussed in Attachment A and above, the most compelling evidence that phosphorus limits algal growth during the mid to late summer period is revealed in the orthophosphate data that has been collected from the lower Basin every summer since 1998. Mirant Kendall's Figures E14-2 to E14-6, which depict some representation of EPA's orthophosphate data for the summers of 1999 to 2002, also illustrate this point, although it is unclear what data are represented by these Figures. A review of Mirant Kendall's Figures submitted to support comment E14 indicates that Mirant Kendall has made errors in the representation of certain critical data. Figure E14-1 indicates a orthophosphate concentration of 88.33 ug/l on 8/11/98, when in fact the following data were collected; CRBL07 - 5 ug/l; CRBL09 - non detect (8.2 ug/l); CRBL10 - 13.6 ug/l; and CRBL11 - 5 ug/l. In fact, although Mirant Kendall's Figure E14-1 is labeled "Eutrophication Water Quality Data for the lower Charles Basin for Summer 1998," the data points are all dated from 1999. Since Figure E14-2 also contains data dated 1999, it is unclear whether Mirant Kendall has mislabeled the data itself or merely the chart.

The actual data indicate that phosphorus was limiting algal growth in the Basin at that time. EPA has noted other discrepancies in these figures. For example, Figure E14-3 shows a TP concentration of 101.88 ug/l on 7/18/00, while the actual data indicate a TP concentration of 73 ug/l (average of TP data from CRBL07, 09, 10, and11). The three chlorophyll *a* points shown on Figure E14-4 for the sampling events around the 9/21/01 storm event, 10.40 ug/l, 8.02 ug/l and 0.03 ug/l, do not represent the actual chlorophyll *a* data collected. The correct data values are 31 ug/l, 29 ug/l, and 25 ug/l (averages of chlorophyll *a* data from stations CRBL07, 09 and 11). Because of these and other errors in Mirant Kendall's figures, no justifiable conclusions may be drawn from the shapes of curves based on Mirant Kendall's questionable data.

In addition to simple errors of data reporting, Mirant Kendall also appears to have made a scientifically inappropriate methodological choice in that it apparently included EPA's wet weather data in its Figures E14-1 to E14-6. EPA does not agree with including wet weather data for the purpose of evaluating algal responses in an impounded river system that receive such high inflows during rain events. EPA has observed that phosphorus levels are temporarily elevated during and following rain events, while chlorophyll *a* levels often decline. It is likely that chlorophyll *a* levels decline because of transport out of the system due to high inflows and pumping at the New Charles River Dam. Furthermore, EPA does not expect that chlorophyll *a* levels would increase immediately in response to the increased TP levels during and shortly after rain events, because the algae need time to grow. In addition, other environmental conditions such as reduced water clarity and less direct sunlight may reduce algal growth rates during this time. Including the representation of wet weather data in Figures E14-1 to E14-6 will tend to mask trends and possible relationships that are evident using the more representative dry weather data.

Despite these discrepancies, EPA has examined Figures E14-1 to E14-6 together with EPA's actual data. This examination supports the position that several of the water quality trends observed during the 2002 summer (true color, TP, orthophosphate, chlorophyll *a*, water clarity) are evident in the other monitoring years (1998-2004), and that phosphorus limits algal growth during portions of the critical summer period. EPA used the 2002 summer data in Figure 2 because it represented greater temporal and spatial coverage in the Basin during an extended dry period. For example, the 2002 monitoring included 6 dry-weather sampling events conducted between June 13 and September 10 at 12 monitoring stations in the lower Basin, compared to 3 dry-weather sampling surveys at 4 monitoring stations in the other years. As a result of the greater temporal and spatial coverage, the 2002 data may be more illustrative of seasonal water quality variations in the lower Basin than data from other years. For example, 6 dry weather sampling events were collected during an extended dry period, and data from 4 of these events indicate phosphorus was limiting algal growth. In the other years, when the dry weather surveys were conducted approximately once per month (July-September), wet weather sampling events often occurred between the dry weather surveys. Also, typically 1 of the 3 dry weather sampling events was conducted when other factors were likely limiting algal growth. In general, fewer points make it more difficult for possible trends to emerge.

EPA agrees that river flow and the resulting hydraulic residence time appears to be an important factor that limits the amount of algal biomass in the Basin at certain times of the year, typically spring, early summer, and sometimes early fall. Also, certain large rain events appear to have a flushing effect on chlorophyll *a* levels. However, the effects of flushing from rain events on algal biomass appears to be short lived. In general, EPA finds that flushing rates during the critical summer period are not sufficient to prevent algal blooms from becoming established, as evidenced by the high chlorophyll *a* data collected from the Basin (1998-2004). As discussed in the Response to E1, the hydraulic residence time of the lower Basin during the summers has been sufficient, even during the relatively high flow summer of 1998, to allow blooms to occur. Thus, other factors such as nutrients are likely to have controlled algal growth during periods when there was sufficient hydraulic residence times to allow algal blooms to become established in the lower Basin.

With respect to Mirant Kendall's claim that the observed chlorophyll *a* levels are acceptable, both the data and the generally accepted guidelines are to the contrary. First, Mirant Kendall focuses on the 30 ug/l chlorophyll *a* observed in October, but neglects to point out a chlorophyll *a* value of almost 60 ug/l at the end of July in addition to the 30 ug/l chlorophyll *a* observed in October. See Figure 2, Attachment A of the Fact Sheet. Moreover, as discussed in Attachment A and notwithstanding Mirant Kendall's unexplained assertion to the contrary, both of these levels are indicative of excessive algal levels or "nuisance bloom levels" in the lower Basin. In December 2001, EPA recommended ambient water quality criteria for TP, TN, chlorophyll a, and secchi depth for lakes and reservoirs. The nutrient-related criteria were developed for 14 ecoregions within the continental United States. EPA's ecoregional nutrient criteria address cultural eutrophication and are considered protective of aquatic life and recreational uses. These criteria are intended to be used by states as a starting point as they move towards adopting nutrient-related numeric criteria in their Water Quality Standards (EPA, 2001). The Charles River Basin is located in subecoregion 59 of Nutrient Ecoregion XIV, the Eastern Coastal Plain. Based on a regional analysis of summer (July-September) chlorophyll *a* data from lakes within subecoregion 59, the New England Coastal Plain, the Regional Technical Assistance Group for nutrient criteria development in New England has proposed a preliminary criterion for average summer chlorophyll *a* of 2.63 ug/l (ENSR, 2000, AR#395).

Furthermore, these high chlorophyll *a* values coincide with TP concentrations of approximately 60 ug/l and 75 ug/l, respectively. The orthophosphate data for the July sampling event indicates that phosphorus is limiting algal growth, while temperature (58 degrees F) and water clarity may have been limiting factors in mid-October.

Finally, with respect to Mirant Kendall's insistence that EPA "identify just what level of increased phosphorus would make any significant difference in nuisance algal blooms," EPA reiterates that it is not the agency's responsibility to develop a credible water quality model to support Mirant Kendall's permit application.

Comment E15: Mirant Kendall argues that whatever the phosphorus levels, the determinative factor in the algal growth in the lower Charles River actually is the amount of flow.

Response to E15: See responses to E1 and E14. Hydraulic residence times are sufficiently long during the critical summer periods to allow algal blooms to become established in the lower Basin. Every summer since EPA began its monitoring of the Basin, including the relatively high flow summer of 1998, chlorophyll *a* levels have indicated bloom conditions in the lower Basin resulting in excursions from Massachusetts Water Quality Standards. During these bloom periods other factors, not flow, have controlled algal growth rates in the lower Basin. The ample data available indicate that nutrients, and in particular phosphorus, limit algal growth rates during those periods when the most severe blooms occur.

Mirant Kendall again suggests that a chlorophyll *a* value of 40 ug/l is an acceptable threshold for the lower Basin. To the contrary, this value far exceeds a value that would protect all designated uses. See response to E14.

Comment related to E15 and E19 from Dr. Stephen Kaiser: The key objection raised by EPA to the diffuser is the potential for algae growth given the advanced eutrophic state of the Charles River. The issue of algae problems was not adequately dealt with in the MEPA review. EPA's comment letter of 1999 raised the concerns about algae growth and should have been highlighted in the permit discussions. The draft permit should have explicitly discussed the problems with the diffuser pipe and its possible contribution to algae growth.

Response to Comment related to E15 and E19 from Dr. Stephen Kaiser: Throughout the permit development process, EPA, DEP, and other regulatory agencies have expressed concerns about the potential for increased algal growth associated with the operation of the proposed diffuser and the increased thermal load from Mirant Kendall's facility. Attachment A to the Draft Permit Fact Sheet discusses these concerns and the basis for EPA's decision not to authorize use of the diffuser in the Draft Permit and to require extensive eutrophication-related monitoring.

Comment E16: Mirant Kendall argues that experience from the MDC aerators in the Charles River shows that the proposed diffuser would destratify the Basin and improve water quality without increasing phosphorus levels in the upper water column. Mirant Kendall argues that EPA, in Attachment A to the Fact Sheet of the draft permit, improperly rejected the MDC aerators as an appropriate analogue.

Response to E16: Mirant Kendall has mischaracterized EPA's basis for not relying on the results of MDC aerator study. EPA did not, as Mirant Kendall claims, "dismiss that past experience on the ground that destratification did not … reduce nutrients in the surface layer of the Basin." EPA's basis for not relying on the MDC study as supporting evidence for use of the proposed diffuser is clearly presented on page 21 of Attachment A to the Fact Sheet. Regardless of the results of the MDC aerator study, a technical analysis specific to the operation of the proposed thermal diffuser is needed to evaluate potential impacts on water quality for the following reasons.

First, EPA has not relied on the results of MDC aerator study to address concerns with the operation of the proposed diffuser because, unlike the MDC aerators, use of the proposed diffuser would introduce a large thermal load into the lower water column which would significantly increase water temperatures and, consequentially, biological and chemical reaction rates. Mirant Kendall has given EPA information that indicates that bottom water temperatures in areas of the downstream portion of the lower Basin would increase by more than 5.6 degrees C (10 degrees F) during operation of the proposed diffuser (TRC, 2001, AR#458). A general rule of thumb is that rates of most reactions in natural waters will approximately double for a temperature rise of 10 degrees C (Chapra, 1997). Increases in the rates of chemical and biological processes in the bottom waters and at the surface of the benthic sediments will increase the consumption of DO and benthic nutrient flux rates and must be considered for the lower Basin.

Secondly, the proposed thermal diffuser would act to destratify the lower Basin in a very different way than did the MDC aerators. Dr. Eric Adams of the Massachusetts Institute of Technology, under contract to TRC (Mirant Kendall's consultant), also concludes that the proposed thermal diffuser is significantly different than the MDC aerators with respect to how destratification would be accomplished (Adams, 2003). While EPA agrees that the proposed thermal diffuser discharge would act to destratify the lower Basin, Mirant Kendall has not provided a credible water quality model that would justify the conclusion that the operation of the proposed diffuser would not degrade the water quality of the lower Basin. Mirant Kendall has failed to provide the necessary technical analysis and evidence specific to the operation of the proposed diffuser to support Mirant Kendall's presumption that the operation of the proposed diffuser would sufficiently raise DO levels in the bottom waters and not increase nutrient loading to the upper water column.

Finally, EPA's position that technical analysis specific to the proposed thermal diffuser is needed before authorizing such a discharge is supported by the inconsistent results of other artificial circulation projects. As discussed earlier in the response to E3, ENSR's evaluation of artificial circulation techniques designed to oxygenate the hypolimnions of stratified waters and control algal blooms found that not all projects were successful (ENSR, 2004). In fact, a review by Pastorok et al. (1982, as cited in ENSR, 2004) of many whole lake artificial circulation treatments found that, in more than half the cases, conditions became worse. Finally, ENSR reports that the greatest risk from artificial circulation involves transport of nutrients and other substances from the bottom to the top of the lake – precisely EPA's concern here.

Comment E17: Mirant Kendall argues that the proposed diffuser's oxygenation of the deeper waters would facilitate the binding of phosphorus to the abundant iron, aluminum and calcium and reduce phosphorus "flux" from the benthic sediments into the water column. Mirant Kendall maintains that higher DO in the water column suppresses nutrient flux to the surface even if some flux occurs at the sediment interface.

Response to E17: EPA has reviewed the permittee's 2004 nutrient/DO profile data and has determined that there is insufficient information to support Mirant Kendall's assertion that raising DO in the water column will be sufficient to suppress overall phosphorus flux rates that might result from operation of the proposed diffuser. Mirant Kendall has not provided the supporting quality assurance/quality control (QA/QC) data and documentation that is needed to verify that the data are acceptable. It appears that at least one data value is erroneous. See the MIT June 23, 2004 TP and orthophosphate data collected at a depth of 8 feet. The orthophosphate value of 0.31 mg/l exceeds the TP value of 0.08 mg/l, which is not possible. Orthophosphate is a component of TP and must always be less than or equal to the corresponding TP value. Also, the phosphorus and DO data collected at both stations on July 9 and July 23 at the 15 foot depth appear inconsistent. While the upstream station, MIT, has elevated phosphorus levels and low DO at the 15 foot depth, the downstream station does not have elevated phosphorus levels despite DO being low. This pattern is inconsistent with EPA's 2002 profile data. EPA would expect to see the elevated phosphorus values at both stations if the low DO was due to the salt wedge.

Moreover, the lack of salinity profile data make it difficult to interpret the data provided and to determine whether the data were collected within, above, or below the pycnocline. The pycnocline in the lower Basin is a narrow transition zone that separates the upper and lower water column and that is characterized by high salinity, temperature and pollutant gradients. It appears possible that some or all of the 15 foot data were collected within the pycnocline and are therefore, not representative of either the lower or upper water column. Setting aside for the moment questions concerning the quality of the data, the profile data collected by Mirant Kendall lack the necessary vertical detail to characterize nutrient gradients throughout the water column. EPA's 2002 profile data, which were collected above and below the pycnocline based on salinity and DO observations, indicate that the salt wedge is effectively trapping much of the phosphorus that is released from the sediments in the lower water column. EPA's data indicate that the upper water column, above the pycnocline, is well mixed with relatively uniform nutrient concentrations.

Finally, Mirant Kendall's phosphorus analysis does not consider the effects of increased advective transport between the bottom waters and the upper water column that would result from the operation of the proposed diffuser. Increased advective transport associated with the operation of the diffuser could readily transport orthophosphate that has been released from the benthic sediments up into the photic zone of the water column where algae can grow.

Comment related to E17 from Roger Frymire: Once you get an oxygen environment established at the bottom of the river, that alone will prevent a high nutrient flux from coming out of the sediments. At the same time, we'll have oxygen to allow clams and bacteria in the bottom sediment to begin some much needed bioremediation.

Response to Comment related to E17 from Roger Frymire: As discussed in the Responses E1-E16, EPA has determined that the potential negative consequences associated with the operation of the proposed diffuser more than offset the potential benefit associated with increasing dissolved oxygen levels in the lower water column. Moreover, EPA has not been presented with convincing evidence that the operation of the proposed diffuser to discharge thermal waste heat to the bottom of the lower Charles River would result in raising dissolved oxygen to levels that are sufficient to oxygenate the bottom sediments, improve the benthic habitat, and inhibit the release of nutrients. A thorough and credible modeling analysis of the operation of the proposed diffuser is needed to demonstrate what the likely impacts on water quality would be to the lower Charles River.

Comment E18: Mirant Kendall contends, citing various data, that there is little or no risk of increases in algal growth and of nuisance blue green algae due to increased thermal output from the plant.

Response to E18: Every summer from 1998 to 2004, water quality monitoring of the Basin shows there have been water quality impairments related to excessive algae in the Basin, even when the facility's thermal load was less than 20% of the allowable permitted load, which occurred during August 1998. Although water quality monitoring data appear to indicate that algal-related water quality problems occur in the lower Basin regardless of the facility's thermal discharge, the important question concerning the facility is how much the discharge has contributed or will contribute (under full permitted thermal load) to the severity of algal blooms and related water quality impairments. EPA has included eutrophication-related monitoring requirements in the permit to provide the necessary information to more fully evaluate these concerns.

EPA disagrees with Mirant Kendall's assertion that the chlorophyll *a* and temperature data from the lower Basin show that Mirant Kendall's thermal discharge is not contributing to increased algal levels in the downstream portion of the lower Basin. Mirant Kendall's evaluation of the effects of thermal discharge on algal growth using only temperature and chlorophyll *a* data from the lower Basin is inappropriate because it ignores the effects of many other factors that are known to influence algal levels in the Basin. As discussed extensively in Attachment A to the Fact Sheet and in other responses, algal levels at any given location are affected by several factors (light, nutrient availability, settling, retention time, and temperature). Mirant Kendall has interpreted existing data collected during the summer of 2002 by assuming that these other factors were constant throughout the lower Basin and between sampling events. Mirant Kendall also has assumed that conditions reflected by data collected at monitoring stations located in close proximity to one another are identical and ignores flow circulation patterns within the lower Basin. Mirant Kendall has not provided evidence to support these assumptions.

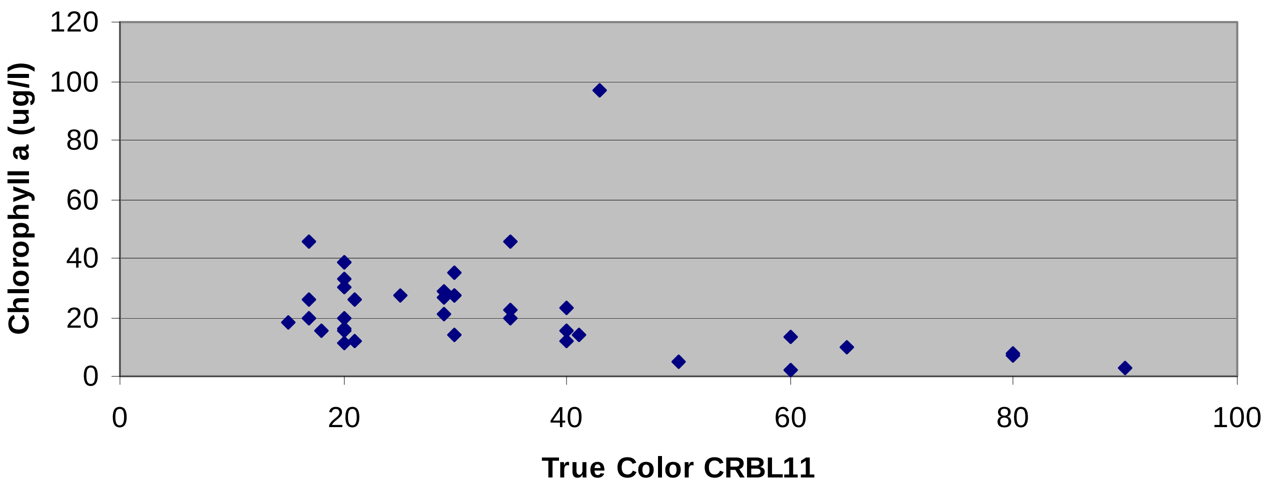
On any given day, water quality and flow circulation conditions vary in the lower Basin. Mirant Kendall's thermal discharge has a major influence on flow circulation patterns in the Lower Basin, as evidenced by temperature data collected from the lower Basin. Measurements of surficial sediment deposits, chlorophyll *a*, and water clarity data in the lower Basin all indicate this spatial variability and show that more algae settle out of the upper water column in the downstream portion of the lower Basin than in the upstream portion. Also, monitoring data show that there is often considerable variability in nutrient concentrations within the lower Basin for a given monitoring day. Furthermore, EPA disagrees with Mirant Kendall's assumption that all conditions with the exception of temperature are constant between summer season sampling events. Water clarity, retention time (i.e. river flow), circulation patterns, and climatic conditions such as cloud cover, wind speed, sunlight intensity and the angle of incidence vary considerably throughout the summer. The spatial and temporal variability of factors that affect algal growth in the lower Basin make it impossible to isolate the effects of temperature alone on algae using ambient water quality data.

Mirant Kendall notes that some of the available water quality data coincide with periods of plant operation near the plant's full permitted thermal load. EPA acknowledges that some of the available data reflect near-full permitted load conditions, albeit only for brief periods of time, and EPA has reviewed that data. However, as explained below, EPA does not agree with Mirant Kendall's usage and interpretations of that data.

Mirant Kendall observes that chlorophyll *a* levels were lower during the early to mid summer of 2003, when the facility was running at 90% of its highest permitted load, compared to late summer chlorophyll *a* levels when the facility was running at 30% of its permitted load. Based on this fact alone, without reference to any potentially interacting or confounding factors, Mirant Kendall contends that its fully-permitted thermal load has little or no influence on algal growth. However, this pattern can be explained by EPA's true color data collected during the summer of 2003. During the July 8 and August 19 sampling surveys, true color values were high, at 90 units and 60 units, respectively, while during the September survey true color dropped to 35 units. True color at the July and August levels indicate that algal growth in the Basin was light limited.

An analysis of true color and chlorophyll *a* data collected in the lower Basin show that when true color values are above 50 units, algal growth appears to be generally depressed (light limited)

Figure E18-1. Chlorophyll a vs. True Color, Lower Charles River Basin (CRBL11 1999-2004)



(see Figure E18-1). EPA credits the considerable research that has been conducted by the scientific community to evaluate the effects of temperature on algal growth rates. This peer-reviewed published research clearly shows that when other factors are held constant, algal growth rates increase with increasing temperature (see pages 16-17 of Attachment A to the Fact Sheet). Mirant Kendall has failed to provide any credible evidence that the results of this research are not applicable to the algal community in the Charles River Basin. Mirant Kendall's approach is rather to assume that the other factors in the lower Basin are constant, and then to conclude from the lack of observed correlation between temperature and chlorophyll *a* that there is, in fact, no relationship between temperature and algal growth. This is erroneous because it ignores the complex interactions in a multivariate analysis and, as the true color data show, the assumption is factually incorrect.

Based on existing thermal discharge and water temperature data, it is readily apparent the permitted discharge has the potential to increase water temperatures in the downstream portion of the lower Basin by more than 5 degrees F. The magnitude of the temperature increase associated with the discharge and the results of the research on the effects of temperature on algal growth rates justify the eutrophication-related monitoring requirements in the Final Permit.

Comment E19: Mirant Kendall disagrees with EPA's concern that additional heat load from the facility could result in an undesirable shift to nuisance species (cyanobacteria, also known as "blue-greens"). Mirant Kendall challenges EPA's computation of a "500% +" potential increase in heat load as misleading. Moreover, according to Mirant Kendall, there is no apparent significant positive correlation to temperature between relative abundance of cyanobacteria and elevated water temperatures at either upstream or downstream stations of varying water temperature. Mirant Kendall further asserts that Kendall Station's discharge essentially never causes nor would it cause the ZPH (or even the ZD) to reach levels associated with dominance by cyanobacteria (blue-greens).

Mirant Kendall contends that the diffuser would reduce the competitive advantage of the more buoyant and less salinity-tolerant blue-greens in favor of species more tolerant of brackish water, notably the diatoms essential as the foundation of the river herring food web.

Response to E19: First, the 500 %+ potential increase in heat load was not, as Mirant Kendall claims, determined by comparing the lowest past load from the mid 1990's with maximum allowable load. Rather, the value was determined by taking the average of the potential increase for each July to September period for 1998 through 2000. The potential increase was determined by comparing the monthly average heat load discharged by the facility during the July to September period to the monthly average permitted load (486.5 MM btu/hr). The average potential percent increase for the July to September period of these three years is 514%. Comparison to these periods were chosen because the chlorophyll *a* data collected from the lower Basin during each of these summers were high and indicate algal-related water quality impairments existed in the lower Basin.

Figures E19-1, E19-2, and E19-3 below present the limited algal taxonomic data collected from the lower Basin (summers of 2001, 2002 and 2003). Although the data sets are not representative of the entire summer growing season for these years, each data set indicates a trend of increasing blue-green presence and predominance as the summer progresses. This predominance of blue-greens occurs when temperatures in the lower Basin are between 25 and 30 degrees C. Also noteworthy is the variation in cell counts among the three years. Cell counts were high in 2001 and moderate in 2002 and 2003. As indicated, the 2002 algal sampling was conducted only once per month and did not coincide with peak bloom conditions that chlorophyll *a* data indicate occurred in the lower Basin during late July and again in late September/early October. Mirant Kendall has claimed that the diffuser would reduce the competitive advantage of the more buoyant and less salinity-tolerant blue-greens. EPA finds this claim to be speculative and unsupported. In fact, existing algal data collected as part of the MDC aerator study, prior to and during the operation of the aerators, show that blue-greens were present, and in several cases represented the predominant group, when salinity levels were elevated (see Table E19-1 below for examples). With these data and the lack of evidence provided by Mirant Kendall to support its claim, EPA will not consider the potential lowering of blue-greens by the operation of the proposed diffuser as a potential benefit of the diffuser.

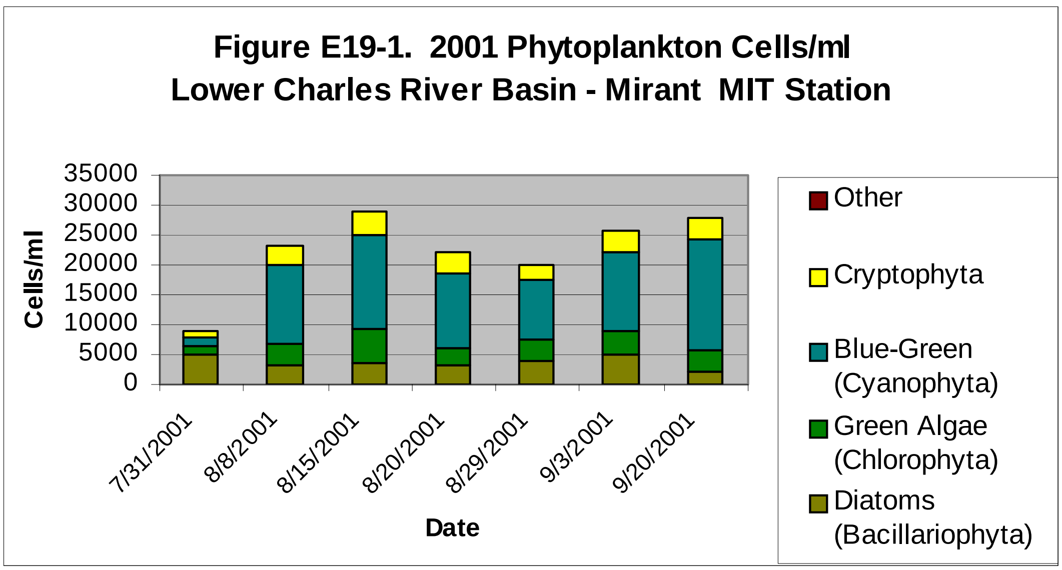
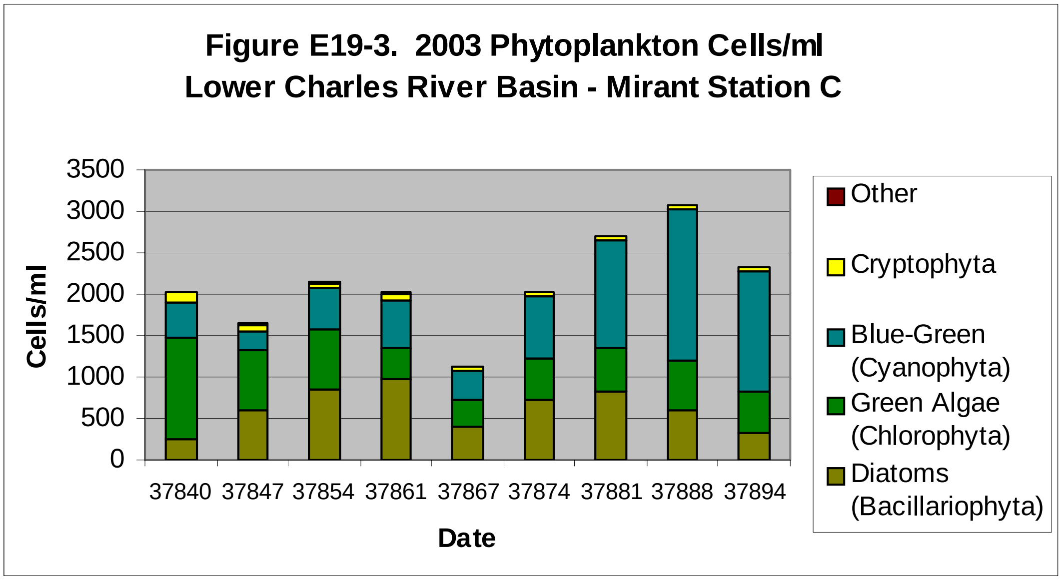


Figure E19-1. 2001 Phytoplankton Cells/ml
Lower Charles River Basin - Mirant MIT Station



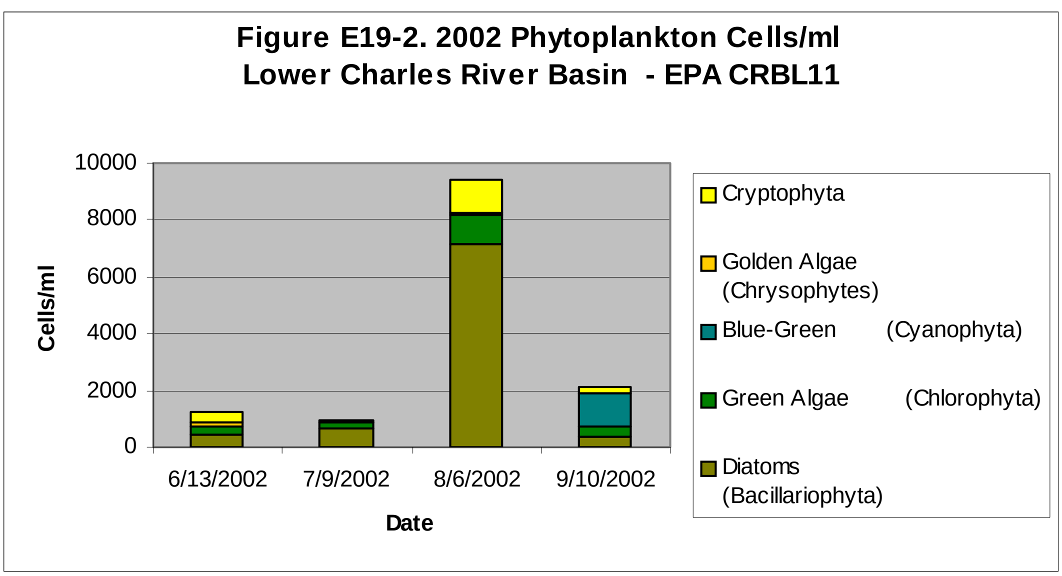


Table E19-1. Example Blue-

green Counts, relative abundance, and salinity measurements from the lower Charles River

Date	MDC Station	Blue-green (count/ml)	% Relative Abundance of Blue-greens	Salinity (ppt)
8/26/1977	5	4180	93	6
8/9/1978	3	2600	58	8
7/23/1979	5	9220	75	5
9/8/1980	3	4200	74	10

Source: MDC Charles River Artificial Destratification Project, Boston, MA, June 1981

Concerns with Mirant Kendall's increased thermal discharge (compared to recent historic levels) and the possibility of the increased proliferation of blue-greens is directly supported by peer-reviewed published research, which indicate that the growth rate of many blue-green species increases more rapidly than other algal groups when temperature rises above 25 degrees C (see Figure 3 in Attachment A to the Fact Sheet). Generally, blue-greens favor conditions with higher temperatures, lower TN:TP ratios, and high pH compared to other algae groups (Mattson et al., 2003). Many blue-greens, particularly the undesirable species, can "fix" nitrogen. While other algae must obtain their nitrogen from ammonium or nitrate in the water, the blue-greens can use atmospheric nitrogen that dissolves into the water. A shortage of inorganic nitrogen or a reduction in TN:TP ratios can give nitrogen-fixing blue-greens a competitive edge. Furthermore, some of the most undesirable blue-greens have other characteristics, such as the ability to float, which furthers their competitive edge. Thus, if other conditions exist that favor blue-greens, then increased temperatures associated with the thermal discharge would likely give blue-greens an additional competitive edge over other algal groups. A very severe blue-green bloom consisting of very high counts of microcystes (known for its potential toxicity to animals and humans) occurred in the downstream portion of the lower Basin during a prolonged period of warm weather in August of 2006. During this period, river temperatures were noticeably elevated from Kendall's thermal discharge. Cell counts of over 1 million cells per milliliter were observed in the river between the Longfellow Bridge and the Museum of Science causing the Massachusetts Department of Public Health to post notices warning people and pets to avoid contact with the water.

In evaluating potential water quality impacts, EPA must consider the impacts of the thermal discharge at permitted loads for extended periods of time. Such conditions have not occurred in the past during the critical season for algal growth while frequent water quality monitoring was conducted. Based on EPA's data, the critical season typically begins in mid-July when true color levels drop and extends to the end of October.

Algal and temperature data collected upstream in the lower Basin and downstream in the vicinity of the discharge were compared to identify any obvious trends between river temperature and algal cell counts. Table E19-2 (attached) summarizes the upstream and downstream blue-green and total algal cell counts measured during the summers of 2001, 2002, and 2003. Due to the influence of other factors (i.e., water clarity, nutrient availability, and settling) that affect algal concentrations, it is virtually impossible to isolate temperature as a sole influencing factor on algal growth in natural waters (Goldman, 1981). The variability of water quality within the lower Basin has already been discussed in this response above and generally shows improvement in the downstream direction. It is probable that environmental conditions, other than temperature, differed between the upstream and downstream stations, which may have affected algal concentrations. Mirant Kendall provided no data to confirm that all other environmental factors (including flow circulation and sedimentation rates) that potentially affect algal concentrations were consistent.

Not surprisingly, the results do not indicate a clear trend with respect to temperature across the three years. The magnitude of the blooms in the lower Basin among these three years appeared to vary considerably, as did river flow (see Table E1-1 from Response E1). However, when data from individual years are examined, trends between blue-green counts and temperature become apparent for two of the three years. The 2001 data (four sampling events) show higher blue-green and total algae counts at the downstream station for two of the four sampling events. These two events correspond with the two highest positive increases in temperature (delta T) observed. In contrast, despite the high delta Ts recorded for all three sampling events in 2002, total algae counts were lower at the downstream station for each sampling event and the blue-greens increased only slightly on one event, September 10, 2002, when the delta T was 4.2 degrees F. The 2003 algal data set was the most extensive, consisting of eight sampling events over a two month period. For all eight sampling events, the blue-green counts were significantly higher (26% to 942 %) at the downstream stations, while total algae counts were higher five of the eight sampling events at Station B and six of the eight sampling events at Station C. For all eight 2003 sampling events, temperatures at the downstream stations (Mirant stations B and C) were higher than at the upstream station, with delta Ts ranging from 0.9 deg. F to 4.5 deg. F .

The 2003 data are of special interest for three reasons: (1) the thermal load discharged by the Kendall Square Station facility was noticeably higher than the previous two summers; (2) the relative differences (i.e., increase) in blue-green counts between the downstream and upstream stations were notably higher than the relative percent differences of total algae between the downstream and upstream stations; and (3) the results are somewhat inconsistent with the typical water quality trend of improving water quality in the downstream direction that has been observed in the lower Basin. The trend of improving water quality in the downstream direction of the lower Basin usually applies to chlorophyll *a*. EPA compared the dry weather chlorophyll *a* data collected by EPA (1998 to 2002) at monitoring stations CRBL06 (upstream - 400 meters downstream of BU Bridge) and CRBL11(downstream - between Longfellow Bridge and the

Museum of Science), and found that chlorophyll *a* concentrations were higher at the upstream station, CRBL06, for 72% (21 of 29) of the paired observations. On average, the chlorophyll *a* concentration at CRBL06 was 39% (15 ug/l) higher than the corresponding value at CRBL11 for those sampling days when CRBL06 had a higher chlorophyll *a* concentration. This trend is diminished in the summer of 2003 when Kendall Station was discharging a greater thermal load. The 2003 algal data collected by Mirant indicate that algal levels in the upstream portion of the lower Basin were higher for only 38% (3 of 8) and 25% (2 of 8) of the sampling events at Stations B and C, respectively. Although increases in temperature may appear to be a primary reason for the increase in blue-green and chlorophyll *a* levels in the downstream portion of the lower Basin, caution must be exercised when interpreting these results since other site-specific factors may have partially contributed to the higher levels in the downstream end of the Basin.

In summary, every summer from 1998 to 2004, water quality monitoring of the Basin has shown that there have been water quality impairments related to excessive algae in the Basin, even during the one month (August 1998) when the facility's thermal load was less than 20% of the allowable permitted load. Although water quality monitoring data appear to indicate that algal-related water quality problems occur in the lower Basin regardless of the facility's thermal discharge, the important question concerning the facility is how much the discharge has contributed or will contribute (under full permitted thermal load) to the severity of algal blooms and related water quality impairments. After considering: (1) the relationship between temperature and algal growth; (2) existing documented water quality impairments in the lower Basin; (3) the 2003 algal data analysis; and (4) the magnitude of the potential increase in thermal load from the Kendall Square Station facility, EPA concludes that the thermal discharge from the Kendall Square Station facility has the continued potential to contribute to excessive algae levels in the downstream portion of the Basin during critical periods of the growing season (i.e., mid to late summer). Therefore, EPA has determined that the eutrophication-related monitoring requirements included in the Final Permit are justified (and in fact necessary) to provide additional information to evaluate the impacts of the facility.

As explained in several of the previous responses, EPA has not received credible evidence to support Mirant Kendall's assertions that the operation of the proposed diffuser will not exacerbate algal blooms in the lower Basin. See, e.g., Response to E1. Based on available information, EPA finds that the operation of the proposed diffuser represents a reasonable potential to contribute to algal blooms in the Basin, and will not permit its operation at this time.

Comment E20: The Agencies' Incorrect Speculation Regarding Increased Salinity. Section 5.1 of the DD states that "[i]ncreased salinity throughout the water column in the lower basin [from the diffuser operation] may pose an environmental stress to resident fish populations." This speculation is restated in Section 5.4.9.

This is unsupported speculation with ample evidence to the contrary. The Agencies estimate the maximum mixed salinity with the diffuser will be 6.5 ppt (Fact Sheet Attachment A, p. 22). Mirant Kendall expects it would be less, especially with time as the salt is mixed and exported from the basin. As documented on Table 5 of Attachment A, however, 6.5 ppt is a value characteristic of historic conditions in the basin. Further, both Mirant Kendall's extensive field collections of resident species at salinities up to 14 ppt in the basin and the available literature data submitted by Mirant Kendall on salinity thresholds for adverse impact on the basin species (see Final Environmental Impact Report (EOEA No. 11754), Response to Comments, §8.2.43, AR#456) indicate the general absence of adverse effects at up to 5 ppt. Precisely what resident species does EPA believe will be impacted and how? Further, how will this redistribution not provide net benefits to those resident species such as yellow perch or largemouth bass which would no longer be pre-empted from their preferred benthic habitats under stratified conditions? Mirant Kendall's gill net data consistently shows that these fish vacate previously preferred locations when salinities reach at or above about 14 ppt.

Response to E20: In order to address the permittee's comment related to the overall health of fish species present in the lower Basin, EPA reviewed relevant salinity information in the scientific literature for two resident species that were also previously evaluated for their sensitivity to temperature (white perch and yellow perch) and one anadromous species (alewife). Optimal salinity ranges (ppt) for these species by life stage are: white perch - 0-2 (eggs), 0-3 (juveniles), and 5-18 (adults); yellow perch - 0-2 (eggs), 0-5 (juveniles), and 0-13 (adults); alewife - 0-2 (eggs), 0-5 (juveniles), and 0-30 (adults). See Funderbunk et al. (1991) AR#364; USFWS, 1983, AR#573 (stating that white perch "spawn in nature generally at less than 4.2 ppt"). It is clear from these data that salinities as high as 6.5 ppt could impact the early life stages of all three of these species.

EPA disagrees with Mirant Kendall's claim that a salinity value of 6.5 ppt reflects historic conditions in the Basin. The table Mirant cited (Fact Sheet Attachment A, p. 22) to support this statement contained surface salinity readings on only six selected days from 1976 through 1980, during the MDC Artificial Destratification Project. It is not accurate to describe this five year time period during a destratification project as a fair depiction of surface salinity values in the lower Charles River Basin.

Contrary to Mirant Kendall's claim that 6.5 ppt is typical of the Basin, water quality profile data from 1999-2005 indicates that, in general, salinity levels in the lower Basin remained below 1 ppt from the surface to approximately a depth of nine feet for the majority of the time in most years. By the end of the summer, when stratification and saline intrusion were most pronounced, salinities from the surface to nine feet were recorded as high as approximately 2.2 ppt (August 20, 2002, Deep Diffuser Station). In general, however, even when salinity levels were most pronounced in the Basin, levels for the most part remained very low (less than 2 ppt) to a depth of at least nine feet (for example: September 27 and October 4, 2005; maximum salinity 1.6; Boston Station). Below this layer, under the fully stratified conditions of late summer, salinity values were seen as high as approximately 38 ppt (August 1, 2003 at 33 ft; Old Channel Station).
To be sure, these data (collected by Mirant Kendall) indicate that salinity from year to year varied depending on rainfall, river flow and the timing and frequency of the New Charles River Dam operation.   Furthermore, EPA acknowledge that isolated atypical readings have been recorded as part of these profiles. For example, at the Deep Diffuser Station on May 24, 2002, at a depth of 9

ft, the salinity was recorded as 32.8 ppt. On May 29, only five days later, salinity levels were below 1 ppt to a depth of 15 feet at that same station.

However, despite these variations and occasional anomalous data points, the overall trend remains the same: salinity less than 2 ppt to a depth of at least nine feet. Nowhere in this broad overview of salinity conditions in the lower Charles River Basin was a value of approximately 6.5 ppt consistent with historic conditions in the Basin. Thus, the consistently low salinity environment present in the upper layer would be eliminated if the diffuser mixed the stratified layers of the Basin to 6.5 ppt.

Mirant's assertion that it has captured individual fish in salinities up to 14 ppt is not compelling evidence to the contrary. First, it can be problematic to state with confidence that a fish was captured in a gill net at a certain depth, under specific water quality conditions. Gill nets deployed by the permittee in the lower Charles River Basin were sometimes set for over 24 hours. River currents and wind can alter the configuration of the net, as well as influence the depth of temperature, DO or salinity boundary layers over the course of a day. Second, these fish could be transient, i.e., moving through (or specifically trying to exit) the saline area at the moment of capture.

Third, and most importantly, a general principle of biology is that a population exhibits a range of responses to a stressor, classically along a bell-shaped curve. Thus, even at levels of a stressor that would cause avoidance by a majority of the population, a minority of exceptionally resistant individuals will be capable of tolerating the stressor. As discussed at length in the DD, regulatory agencies do not make judgments based on the fact that some individual fish can be found under conditions that would stress the majority. The capture of individuals within an area of high salinity does not demonstrate that large numbers of the species regularly occupy that habitat. See generally Response to comment related to C2 and C3 from CLF. In the case of the lower Basin, the evidence is clear that optimal salinity ranges for <u>eggs</u> of all three species discussed fall well below 5 ppt.

With respect to the benefits of mixing the 14 ppt saline layer, EPA acknowledges that if a deep water discharge diffuser mixes the lower Basin in the manner described by the permittee, the benthic layer currently occupied by the salt wedge would have a reduced salinity (possibly as low as 6.5 ppt). However, as stated above, (1) the salt wedge occupies a relatively small portion of the total volume of the Basin in most years and, consequently, any incremental benefit of reducing the salinity in these regions through mixing would be more than offset by the adverse impact of <u>increasing</u> the salinity throughout the rest of the lower Basin as the same mass of salt is dispersed over a larger volume, and (2) because of the characteristics of the benthic sediments, the regions currently affected by the salt wedge would still provide poor habitat even if salinity were reduced to approximately 6.5 ppt. See Response to E1, part 3.

In the absence of verifiable hydrodynamic models (see Introduction to Section E), Mirant Kendall failed to provide sufficient information to predict the salinity changes that can be expected from the diffuser. The 6.5 ppt estimate for the lower Basin's salinity after mixing by the proposed diffuser was an estimate that EPA made based on available information. However, the salinity in the lower Basin, once mixed by the proposed diffuser, could in fact reach much higher levels for certain periods of the year. For example, Mirant Kendall itself estimated that surface-to-bottom salinity under the proposed diffuser could range as high as 10 ppt for certain parts of the year. See E-mail from John P. Reynolds, Mirant, to Todd Callaghan, MA CZM (Apr. 18, 2003). This uncertainty in the resulting fully mixed salinity value must be taken into account when evaluating the impact of the diffuser on the fish habitat of the lower Charles River Basin.

Comment E21: Mirant Kendall disputes EPA's determination that there is a potential for release of pollutants (including nitrogen, phosphorus, cadmium, lead, mercury, pesticides, PCBs and PAHs) from contaminated sediments due to oxidation and fluxing as a result of operating the proposed diffuser. First, Mirant Kendall argues the levels of contaminants in the deoxygenated area generally are much lower and never higher than the levels throughout the rest of the lower Charles River Basin, which is adequately oxygenated and currently provides habitat for the BIP.

Second, Mirant Kendall states that the experience before and during the operation of MDC aerators 4 and 5 between 1978 and 1981 showed that water column levels of these contaminants did not increase. Third, Mirant Kendall asserts that its flux modeling indicated that there would not be any significant increase on diffuser startup. Finally, Mirant Kendall contends that the sediment levels of iron and aluminum in the Charles are very high and would promote phosphorus reduction.

Comment related to E21 from CRC: We are very concerned that potential eutrophication effects and chemical changes that could destabilize toxic sediments have not yet been adequately predicted and controlled.

Response to E21 and related comment: Mirant Kendall has misrepresented the nature of sediment contamination in the area of the proposed diffuser. The USGS sediment data collected from the Basin indicate that the levels of the contaminants mentioned (e.g., lead, copper, cadmium, mercury and nickel) are above some of the levels observed elsewhere in the lower Basin, and are in fact approximately equal to or above the median concentrations of all the sediment samples collected from the Basin. Also, the USGS data show that the sediments in the "deoxygenated" area have the lowest total solid percentages (i.e, most fluid sediments) throughout the Basin. The high pore water volume of these sediments increases the opportunity for chemical diffusion between sediment pore water and the overlying water column. Furthermore, the fluid sediments would likely be easily disrupted during start up of a bottom diffuser.

While the levels of the contaminants are similar to those in sediments of other areas in the lower Basin, EPA has not been sufficiently convinced by information presented by Mirant Kendall that increased vertical mixing associated with the proposed bottom diffuser above these highly porous sediments would not effectively mix contaminants that have been released from the benthic sediments into the water column and not cause toxicity to aquatic life.

Mirant Kendall has also mis-characterized the results of the MDC study by implying that data from the aerator study showed “that water column levels of these contaminants did not increase.” The MDC aerator study did not involve monitoring of trace metals or other toxicants, and therefore, did not show that these contaminants decreased in the water column following destratification.

EPA has reviewed Mirant Kendall’s submission concerning the fate of trace metals in the lower Basin (AR #296). While EPA appreciates Mirant Kendall’s efforts to evaluate the potential fate of metals in the lower Basin related to the operation of the proposed diffuser, the submission fails to adequately address EPA’s concerns. The first component of Mirant’s evaluation, which relies on EPA surface DO and metals data at CRBL12, does not provide convincing evidence that the diffuser will not result in an increase in metals concentration in the water column. The data were collected at the surface during stratified conditions, when vertical mixing between the lower and upper water column was minimal to non-existent.

The modeling analysis performed on behalf of Mirant Kendall also fails to satisfactorily address EPA’s concerns. In fact, with respect to lead criteria exceedances, Mirant Kendall’s modeling analysis actually exacerbates those concerns. Although some assumptions used in the modeling, such as the complete liberation of the metals from the sediments to the pore water, can be considered conservative (i.e., likely to result in over-predictions), other key assumptions are not conservative and would likely result in under predictions. For example, the sediments were assumed to be 20 percent solids in Mirant’s model (i.e., pore water volume of 80 percent) while the USGS data indicates the sediments are approximately 8 percent solids (station no. 14). Also, Mirant’s model assumed that the active sediment depth for diffusion is 12 inches. This estimate is likely to be low for such fluid sediments. The modeling also assumes that only a sediment area of 20,000 square feet (½ acre) would be oxidized. This assumption fully contradicts Mirant Kendall’s claims that the proposed diffuser would effectively oxygenate most of the benthic sediments in the downstream portion of the lower Basin. Finally, even setting aside these inappropriate assumptions, the model results for all scenarios indicate that chronic criterion for lead (~ 2 ug/l) would still be far exceeded.

Based on this analysis alone, EPA cannot authorize the operation of the diffuser because Mirant’s own model predicts that the operation of the diffuser would cause and/or contribute to violation of Massachusetts Water Quality Standards.

With respect to the flux of nutrients, the Agencies have addressed this topic in several other responses. See Responses to E1, E3, E14, E16, E17 and E19.

Comment E22: Mirant Kendall disagrees with Section 5.1 of the DD, which states the increase in bottom water temperature with the diffuser in operation will be “significant”, “not part of normal seasonal habitat”, and result in a “…reduction in cool water refuge.” Mirant Kendall argues that there is no existing cool water refuge to reduce - rather there is only a cool, saline water zone that cannot be used. The conservative/reasonable worst case increase in bottom temperatures (April, 2001 Supplemental Modeling Report - 1999 cases defined by the Agencies, A.R. No 458) showed no increases beyond the bottom water temperatures voluntarily occupied by the species in question (e.g., low 80s, comparable to the temperatures repeatedly occupied by resident yellow perch at upstream beach seine sites). As a result, deep water habitat will increase with the diffuser rather than be reduced

Moreover, in the winter, when absence of warm enough oxygenated deep water habitat now squeezes resident populations, the added heat and oxygen together will benefit the BIP of yellow perch and the other resident species. The diffuser also will reduce severe vertical Delta T, and thereby eliminate the potential stress of rapid vertical position change by fish, e.g., when pursued by predators. EPA should specify just which species and what temperatures justify this speculation in view of the contrary evidence cited here.

Response to E22:

1. During the later part of the summer, the deep water layer often becomes anoxic due to saline intrusion from Boston Harbor and a lack of mixing. However, EPA's observation pertained to the early summer. As stated in the DD (Section 2.5), in the early summer, deep water that still contains sufficient oxygen is sometimes 9 ºC (~16.2 ºF) cooler than surface waters (example: July 5, 2000; Museum Station). This deeper, cooler water is available as a cool water refuge for fish when surface temperatures rise. If the Basin were to undergo the mixing proposed by diffuser operation, the difference in temperature between surface and deeper waters is projected to be much less. This mixing effect may substantially reduce the cool water refuge currently available to fish when surface temperatures rise and deeper water has not yet been depleted of oxygen.

Water quality data made available by the permittee in April 2006 also document this condition. As late in the summer as July 20, 2005, for example, vertical profile data from the Boston Station records temperatures between 85.9 and 85.6º F in the upper nine feet of the water column. The temperature recorded at a depth of 15 feet at this location was 77.3º F, with an associated salinity of 0.8 ppt and a DO of 5.78 mg/l (Mirant Kendall 2006). This 15 foot depth represented a potential cool water refuge with acceptable salinity and DO that was available to fish seeking to escape the very warm temperatures from the surface to nine feet deep. If Mirant Kendall is correct in stating that the proposed diffuser would fully mix the lower Basin, the diffuser would also prevent the formation of this cool water refuge. Fish species that have been shown to use cool water refuges include yellow perch, common shiner, and striped bass.

In short, EPA's statement regarding loss of deep water refuge habitat pertained to those time periods – typically in early summer, but sometimes as late as mid-July – when oxygen levels are still high enough to provide habitat for fish species, and thermal stratification ensures cooler temperatures in these deep waters. Mirant's proposed diffuser would eliminate this habitat.

2. While EPA acknowledges that resident yellow perch have been collected at upstream beach seine sites at temperatures in the low 80's ºF, this does not appear to be the preferred temperature of this species in the lower Basin.

3. The limited gill net data collected in the winter of 1999 and 2000 in the Broad Canal does not contain a sufficient number of locations or quantity of data to support Mirant Kendall's statement that resident species are impacted by an absence of warm enough oxygenated deep water habitat that squeezes resident populations during winter. Gill net data sampling from 2002-2005 is also insufficient to address winter conditions. This data set began no earlier than April and ended in October. Consequently, Mirant Kendall has not provided sufficient fish collection data from the winter that would support this statement.

Comment E23: Throughout the Fact Sheet Attachment A of the Fact Sheet, EPA calls for numerical modeling of the diffuser to evaluate potential eutrophication impacts. EPA has been conducting such modeling for the overall Basin as part of their development of a Total Maximum Daily Load (TMDL) for nutrients. Mirant is willing to work with EPA's modeling team to refine its model and simulate the diffuser. Mirant is concerned, however, that the subject matter necessitates "instructing" the model about how to handle some of the key variables where the basis for "prediction" is inadequate and posed several questions concerning the development of the model.

Response to E23: See Responses to A12, A13, E1, and E3. EPA has no plans to carry out the modeling simulations of the operation of the diffuser. Mirant Kendall has been informed of its responsibility to develop a credible model of the diffuser and to perform the necessary simulations of the diffuser. Consequently, Mirant Kendall has chosen to incorporate the diffuser into the model recently developed by the Agencies for the lower Charles River nutrient TMDL. Mirant Kendall has begun the process of performing this work. EPA has offered and provided assistance to Mirant Kendall in initializing the model. Also, EPA has outlined in a letter to Mirant Kendall (letter to Shawn Konary from Mark Voorhees dated January 11, 2006) its expectations for the diffuser modeling analysis, including scenarios that should be performed.

EPA has met twice with representatives of Mirant Kendall (on February 2, 2006 and April 18, 2006) to discuss the diffuser modeling analysis and the process that would yield results and expedite the review process. This process involves Mirant Kendall performing the analysis in a stepwise manner, such that technical reviews can be performed on key components of the work before subsequent work which builds on these components is performed. Key components of the analysis requiring interim technical reviews and approvals by EPA are: (1) calibration and verification of the high spatial resolution (i.e., fine grid) hydrodynamic model of the lower Charles River; (2) calibration and verification of the linked water quality-fine grid hydrodynamic model; (3) proposed approach to model operation of the diffuser; and (4) prediction of hydrodynamic and water quality impacts of the proposed diffuser.

Prior to the April 12 meeting, Mirant Kendall provided some initial results of model simulations using the fine grid model and with the proposed the diffuser. Mirant Kendall's representatives indicated that the results were preliminary and that additional work would be performed. EPA reviewed these results, which were again submitted in a letter to EPA and MassDEP (letter to David Webster and Philip Weinberg from Shawn Konary dated July 12, 2006). With the latter submission, Mirant Kendall requested EPA and MassDEP to consider the results prior to issuing the Final Permit. EPA has found the results to be preliminary and insufficient to allow EPA to determine how the hydrodynamic and water quality models are performing or what impacts the proposed diffuser might have on the water quality of the lower Charles River. EPA understands from discussions with representatives of Mirant Kendall at the April 12, 2006 meeting that additional documentation and model results will be provided by Mirant Kendall that are consistent with level of detail outlined in EPA's January 11, 2006 letter.

The modeling questions posed by Mirant Kendall are not relevant to this Final Permit as the model has not been used to develop the permit. However, as part of the public participation process for the Charles River Basin nutrient TMDL, Mirant Kendall will have an opportunity to review the model and pose questions.

Comment E24 (from Mark Jaquith): My final objection is with the proposed diffuser pipe. While the use of a diffuser of this type may in fact be a better way to disperse their waste heat, this placement (as proposed) cannot be used because it runs right through a mooring and anchorage area administered by the DCR and would be in direct conflict with a historic and highly cherished use in this section of the basin.

Response to E24: EPA is not authorizing the use of the proposed diffuser in the Final Permit, but notes Mr. Jaquith's concern. If Mirant Kendall elects to submit a credible diffuser modeling analysis in the future that would support an application for a permit modification to allow construction and operation of the proposed diffuser, members of the public, DCR, and other state and local agencies will have an opportunity to comment as part of any permit modification process. At this time, analysis of this issue would be premature given EPA's decision not to permit the proposed diffuser.