APPENDIX 4.2.5

MARINE BIOLOGY TECHNICAL MEMOS

APPENDIX 4.2.5.1

DIFFUSER ENTRAINMENT MEMO FOR FINAL EIR

mbc AQUATIC SCIENCES

6 March 2019

Mark Donovan, PE
GHD
Desalination Program Manager
320 Goddard Way, Suite 200
Irvine CA 92618
mark.donovan@ghd.com

Re: Review of Plumes 18b Modeling Deleterious Diffuser Entrainment
Doheny Desalination Project

Hello Mark:

I reviewed the Plumes 18b report (Jenkins 2019) for the South Coast Water District Doheny Desalination Plant (DDP) and the following are my thoughts.

The results presented in Jenkins Table 3 (buoyant discharge scenarios) and Table 5 (non-buoyant discharge scenarios) include: depth of maximum plume rise, distance to maximum plume rise, volume of water with deleterious entrainment (entrainment mortality), the incremental change in the volume compared to baseline, diameter of the zone of initial dilution (ZID), and the incremental change in ZID diameter.

The buoyant discharge scenarios (Jenkins Table 3) all result in reduced entrainment mortality and smaller ZIDs. Therefore, Jenkins posits that "*no mitigation should be required for DDP (Doheny Desalination Plant) operational scenarios that result in buoyant combined discharges with SOCWA wastewater*."

Table 1. Modeling Summary (note both feet and meters are reported)

	Distance to maximum rise (ft)	Deleterious entrainment volume at maximum rise (mgd)	Incremental reduction in diffuser entrainment (mgd)	ZID diameter (m)	Incremental reduction in ZID diameter (m)
Buoyant scenarios	48.5–68.9	1,702–6,992	33–1,615	63–196	5–188
Non-buoyant scenarios	<1–20.1	67–729	N/A	N/A	N/A

The non-buoyant discharge scenarios (Jenkins Table 5) result in entrainment mortality volumes that range from 67 to 729 million gallons per day (mgd). These volumes "*are to be throughput to the ETM/APF (Empirical Transport Model/Area Production Foregone) calculus to compute the mitigation scaling for DDP diffuser turbulent impact*".

For simplicity, I'll refer to the "volume of deleterious entrainment" as "TM (turbulence mortality) volume". The volumes calculated above are high relative to the actual discharge volumes at the outfall. For example, the baseline discharge of 8 mgd of wastewater results in TM volume at maximum rise of 3,004 mgd, or 376 times the discharge rate. For comparison, when San Onofre Nuclear Generating Station was operational, each unit discharged approximately 1,200 mgd of cooling water (2,400 mgd total for Units 2 and 3).

If ETM/APF is the required approach, the required denominator for proportional entrainment is the source water volume. The APF estimates that we presented in the Draft EIR (Appendix 10.4.1) were based on an estimated source water with dimensions 2 km cross-shore, 25.9 km longshore, and 20 m deep. The longshore distance was based on a current speed of 6 cm/sec. The total source water volume was estimated at approximately 54,779 x 10^6 gallons.

The ETM/APF approach has been used for power plants and desalination facilities, and the focus has been fish eggs and larvae, and target meroplankton such as crabs, squid, and spiny lobster. We have not sampled plankton in the nearshore waters of Dana Point, but performed a year-long plankton study off San Onofre in 2006-7 (MBC 2007). The most abundant fish larvae during studies at San Onofre were Northern Anchovy (*Engraulis mordax*), unidentified anchovies (*Engraulidae*), Queenfish (*Seriphus politus*), and clinid kelpfish (*Gibbonsia* spp). The most abundant fish eggs were Engraulid eggs, unidentified fish eggs, and Sciaenid/Paralichthyid/Labrid eggs. The table below summarizes known egg sizes and hatching lengths for relevant taxa (from Moser 1996), and the percent contribution of each taxon to the egg/larval total in entrainment samples (MBC 2007).

Table 2. Sizes of fish eggs and larvae, and contribution to totals off San Onofre.

Species	Egg diameter (mm)	% contribution to egg total	Hatch length (mm)	% contribution to larvae total
Northern Anchovy	1.23–1.55*	42.8[†]	2.5–3.0	38.5
Deepbody Anchovy	0.6–0.9		1.5–2.5	20.3[††]
Queenfish	0.73–0.78	1.3[‡]	~1.6	5.9
Spotted Kelpfish			4.5	5.8[‡‡]
Giant Kelpfish	1.2–1.4		5.1–6.2	0.6

* Eggs of N. Anchovy are elongate. These are the lengths in the longest dimension.
† Engraulid eggs include N. Anchovy (*E. mordax*) and Deepbody Anchovy (*A. compressa*).
[††] Engraulid larvae (unidentifiable to species).
‡ Sciaenid eggs (unidentifiable to species).
‡‡ *Gibbonsia* spp larvae (unidentifiable to species).

In the case of the DDP, it is assumed that TM is limited to organisms <1 mm in size, which would exclude fish larvae and some fish eggs.

This preliminary analysis uses the same assumptions described above, but depth is now considered to be 31 m (centered on the diffuser section). Because the focus is now on organisms <1 mm, we are now analyzing zooplankton instead of fish eggs and larvae (we assume phytoplankton are not of concern). Zooplankton are distributed throughout the water column and migrate vertically to various degrees (Mullin 1986). Zooplankton can be divided into microzooplankton (smaller than ~300 µm) and macrozooplankton (larger than ~300 µm). Microzooplankton feed on particulate organic sources, and consist of protozoans and juvenile stages of metazoan plankton, such as copepod nauplii and early copepodites (Dawson and Pieper 1993). Macrozooplankton include organisms such as gelatinous zooplankton, chaetognaths, copepods, cladocerans, and ostracods.

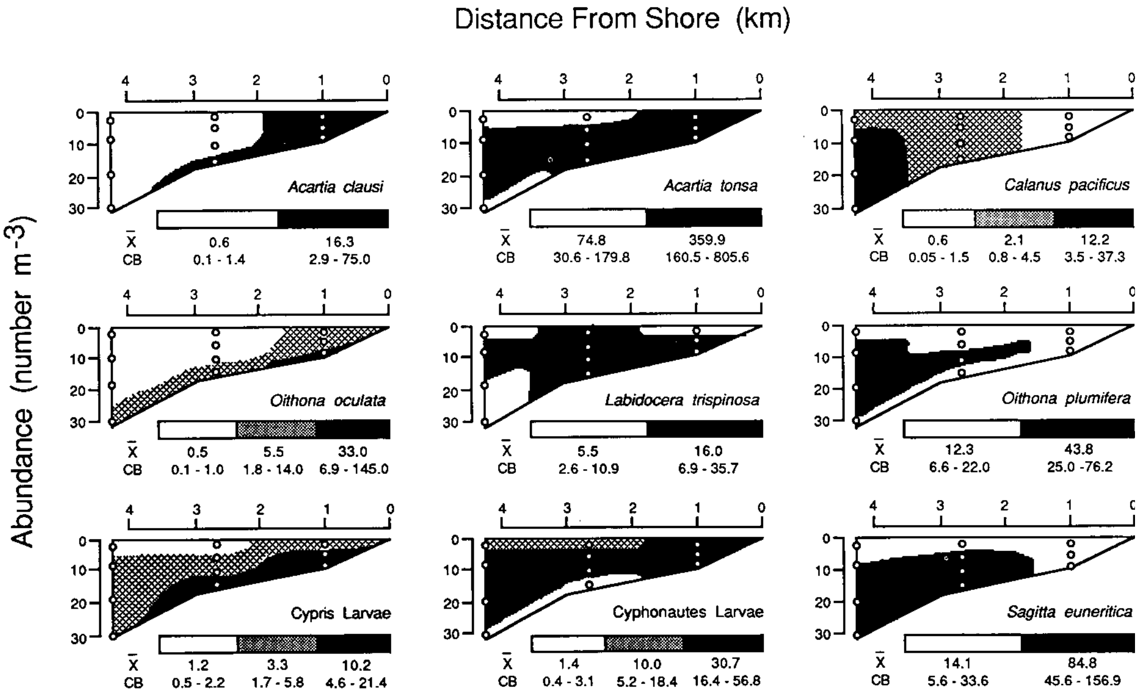

Figure 1. Mean cross-shore abundance profiles of nine zooplankton taxa off San Onofre, 1976 to 1980. From Barnett and Jahn (1987).

As mentioned earlier, the buoyant discharge scenarios all result in smaller TM volumes. The following estimates were calculated for the non-buoyant discharge scenarios, and are based on a source water volume of 87,235 x 10^6 gallons and a larval duration of one day. Note that these are not based on any empirical biological data, and we have no data to characterize spatial or temporal patterns of zooplankton abundance in the immediate project area. This data will ultimately be required for preparation of the Marine Life Mortality Report (per the Ocean Plan, III.M.2.e.1.a [Marine Life Mortality Report]).

Table 3. Probability of Mortality (P_M) and Area Production Foregone (APF) Estimates for DDP based on TM volumes from Jenkins (2019) and a larval duration of one day. The P_M and APF estimates were calculated using the TM volume at the bottom hit of the plume, which was larger than the maximum rise volume for both scenarios.

Non-buoyant Scenario	Wastewater + brine discharge rates (mgd)	TM volume (mgd) at maximum rise of plume	TM Volume (mgd) at bottom hit of plume	Probability of Mortality (P_M)	Area Production Foregone (acres)
1	0 + 3	78.09	120.78	0.00138	3.54
3	0 + 5	95.4	189.7	0.00217	5.57

Potential effects to zooplankton from entrainment in power plants and desalination facilities have not been analyzed in recent studies in southern California. The California Energy Commission published several reports that attempted to summarize standard collection and analysis methods for power plant entrainment studies. The report Assessing Power Plant Cooling Water Intake System Entrainment Impacts, Steinbeck et al (2007) determined:

"*Entrainment affects all types of planktonic organisms, but most studies do not assess holoplankton (phytoplankton and zooplankton that are planktonic for their entire life) because their broad geographic distributions and short generation times reduce the effects of entrainment on their populations. In contrast, the potential for localized effects on certain fish populations is much greater, especially for power plants located in riverine or estuarine areas where a large percentage of the local population may be at risk of entrainment (Barnthouse et al. 1988, Barnthouse 2000). Although the potential for similar effects exists for certain invertebrate meroplankton (for example, crab and clam larvae), taxonomy of early larval stages of many invertebrates is not sufficiently advanced to allow for assessments at the species level.*"

EPRI (2007) summarized analysis of plankton for the SWRCB as follows:

"*The entrainment performance standard for entrainment reduction in the EPA Rule focuses on addressing impacts to fish and shellfish rather than lower tropic levels such as phytoplankton and zooplankton. There are several reasons why there is a low potential for impacts to phytoplankton and zooplankton and why it made sense for EPA to focus on effects on fish and shellfish. EPA recognized the low vulnerability of phytoplankton and zooplankton in its 1977 draft §316(b) guidance (USEPA 1977). The reasons include the following*:

- *The extremely short generation times—on the order of a few hours to a few days for phytoplankton and a few days to a few weeks for zooplankton;*

- *Both phytoplankton and zooplankton have the capability to reproduce continually depending on environmental conditions; and*

- *The most abundant phytoplankton and zooplankton species along the California coast have populations that span the entire Pacific, or in some cases all of the world's oceans. For example, Acartia tonsa, one of the common copepod species found in the nearshore areas of California has a distribution that includes the Atlantic and Pacific coasts of North and South America and the Indian Ocean*."

From the CalAm Draft EIR (ESA 2017):

"*The minimum and maximum discharge velocities (7.4 ft/sec (2.26 m/sec) and 14.8 ft/sec (4.51 m/sec)) modeled across all scenarios for the proposed MPWSP (see Appendix D1) closely approximate the discharge velocities calculated by Foster. Foster (2013) concludes that, at these very small eddy scales: "Overall, the area of high shear impacted by the diffusers is relatively small and transit times through the region short. Thus, it seems reasonable to expect that, while the larvae that experience the highest shear will most likely experience lethal damage, the overall increase in mortality integrated over the larger area will be low.*"

When the environmental effects for San Onofre Nuclear Generating Station were being evaluated in the 1980s, the Marine Review Committee determined intake losses of zooplankton of about 1,350 metric tons per year were not a substantial adverse effect, so no mitigation was required (Ambrose et al. 1990). However, SCE was required to mitigate for losses to fish and kelp, and is prepared to double the size of the mitigation reef off San Clemente to achieve compliance with mitigation requirements (CSLC 2019).

The point of these references is to note that there has been little interest in analysis of potential effects to holoplankton in the last 30 years or so. For CalAm, they actually did a plankton survey in Monterey Bay, but ended up with the conclusion above that the effects would be minimal given the short duration and small area considered.

Please let me know if you would like any more information.

Respectfully,

MBC *Aquatic Sciences*

Shane Beck
President

Cc: K. Thomas (Kimley-Horn), D. Vilas (MBC)

References:

Ambrose, R.F., T.W. Anderson, B. Nelson, R. Stoughton, S.L. Swarbrick, and B.M. Williamson. 1990. Technical Report to the California Coastal Commision. H. Mitigation. Marine Review Committee, Inc. Feb. 1990.

Barnett, A.M. and A.E. Jahn. 1987. Pattern and persistence of a nearshore planktonic ecosystem off southern California. Cont. Shelf Res. 7:1-25.

California State Lands Commission. 2019. Final Subsequent Environmental Impact Report for the Construction and Management of an Artificial Reef in the Pacific Ocean near San Clemente, California (Wheeler North Reef Expansion Project). Prepared in coordination with Dudek. Jan. 2019.

Dawson, J.K. and R.E. Pieper. 1993. Zooplankton. Ch. 6 in: Dailey, M.D., D.J. Reish, and J.W. Anderson (eds.). Ecology of the Southern California Bight: A synthesis and interpretation. U.C. Press, Berkeley, Calif. 926 p.

Electric Power Research Institute (EPRI). 2007. Assessment of Cooling Water Intake Structure Impacts to California Coastal Fisheries. EPRI, Palo Alto, CA. 132 p.

ESA. 2017. Draft Environmental Impact Report/Statement: CalAm Monterey Peninsula Water Supply Project. Prepared for Calif. Public Util. Comm. and Monterey Bay Nat. Mar. Sanctuary. Jan. 2017.

MBC Applied Environmental Sciences. 2007. San Onofre Nuclear Generating Station, Clean Water Act Section 316(b) Impingement Mortality and Entrainment Characterization Study. Prepared for So. Calif. Edison. Dec. 11, 2007.

Moser, H.G. 1996. The Early Stages of Fishes in the California Current Region. Cal. Coop. Ocean. Fish. Invest. Atlas No. 33. Nat. Mar. Fish. Serv., Southwest Fish. Sci. Center, La Jolla, Calif.

Mullin, M. 1986. Spatial and temporal scales and patterns. Ch. 6 in: Eppley, R. W. (ed.). Plankton Dynamics of the Southern California Bight. Lecture Notes on Coastal and Estuarine Studies. Springer-Verlag, New York, N.Y.

Steinbeck, J., J. Hedgepeth, P. Raimondi, G. Caillier, and D. Mayer. 2007. Assessing power plant cooling water system entrainment impacts. CEC-700-2007-010. Prepared for the Calif. Energy Comm. 105 p. plus appendices.

APPENDIX 4.2.5.2

BRINE DISCHARGE MEMO FOR FINAL EIR

MBC AQUATIC SCIENCES

7 March 2019

Mark Donovan, PE
GHD
Desalination Program Manager
320 Goddard Way, Suite 200
Irvine CA 92618
mark.donovan@ghd.com

Re: Review of Dense-Discharge Associated Impacts for the Doheny Desalination Project

Hello Mark:

This memo was prepared to review a range of impacts related to the discharge of dense (negatively buoyant) discharge scenarios presented in the Plumes 18b report (Jenkins 2019) prepared for the South Coast Water District Doheny Desalination Plant (DDP).

Based on Jenkins (2019) there are two separate impacts to the marine environment from the discharge of the dense plume: shear stress mortality as the plume is released from the diffuser ports, and the introduction of a sinking, concentrated brine into the marine environment. Shear stress impacts as a result of a dense discharge were reviewed in MBC Aquatic Sciences' (MBC's) memo *Review of Plumes 18b Modeling Deleterious Diffuser Entrainment Doheny Desalination Project* dated 6 March 2019 and will be discussed further later. This memo will determine the area of exposure of the benthic habitat to elevated salinity levels and later combine the two impacts to determine area of impacts as a starting point to evaluate appropriate mitigation.

The California Ocean Plan (SWRCB 2015) allows for an area of initial mixing of concentrated brine discharges as described below:

> *Discharges shall not exceed a daily maximum of 2.0 parts per thousand (ppt) above natural background salinity measured no further than 100 meters (328 ft) horizontally from each discharge point. There is no vertical limit to this zone.*

This area is defined as the Brine Mixing Zone (BMZ). For the Doheny Desalination Project the 328 feet (ft) regulatory limit of the BMZ is displayed in Figure 1. This figure illustrates the BMZ at 328 ft in all directions from the discharge pipe for the 1,488 ft of the pipeline on which diffuser ports are located. The area of the allowed BMZ for the project is 20.1 acres.

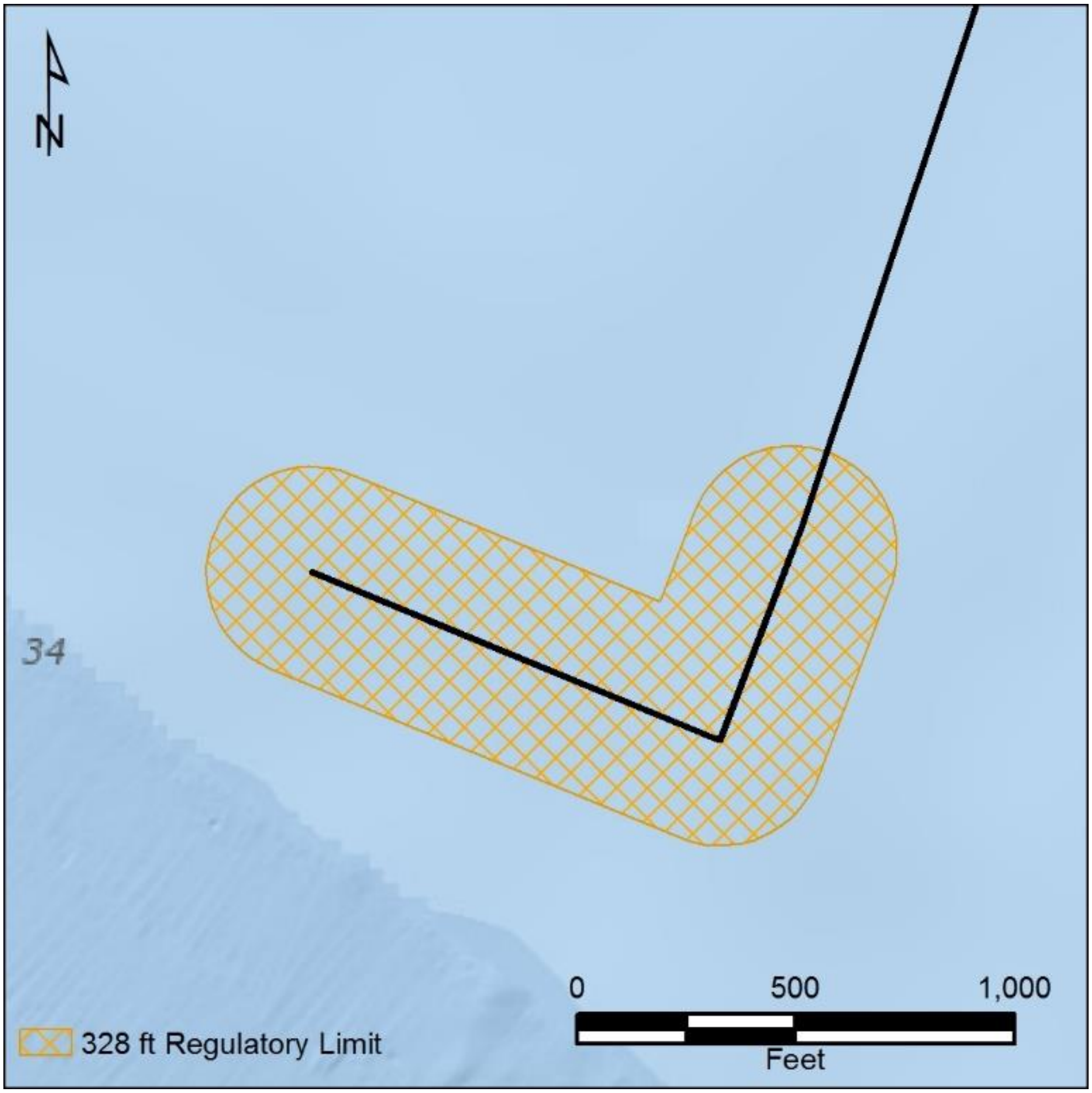

Figure 1. The 328 foot regulatory limit of the BMZ at the project location.

Jenkins (2019, Table 5) modeled eight brine mixing scenarios which would result in a dense plume. Of these, two scenarios, the discharge of 3 million gallons per day (MGD) and 5 MGD of 67 ppt brine with no wastewater dilution, have a remote chance of occurring in the future. Jenkins calculated the distance at which the 2 ppt above ambient salinity is met for the 3 MGD discharge is less than 0.6 ft from the discharge pipe, and for the 5 MGD discharge the limit is met less than 0.7 ft from the pipe (Figure 2). In a worst-case scenario, the discharge of 15 MGD of 67 ppt brine with no wastewater dilution, the salinity mixing meets the 2 ppt limit less than 2.5 ft from the discharge pipe.

Using GIS tools, MBC determined the area of exposure of the benthic habitat to salinities in excess of 2 ppt above ambient for both of the low-likelihood discharge scenarios and for the worst-case scenario (Table 1). To be conservative the area of the pipe was included in in the calculation of these exposure areas. For both low-likelihood dense discharge mixing

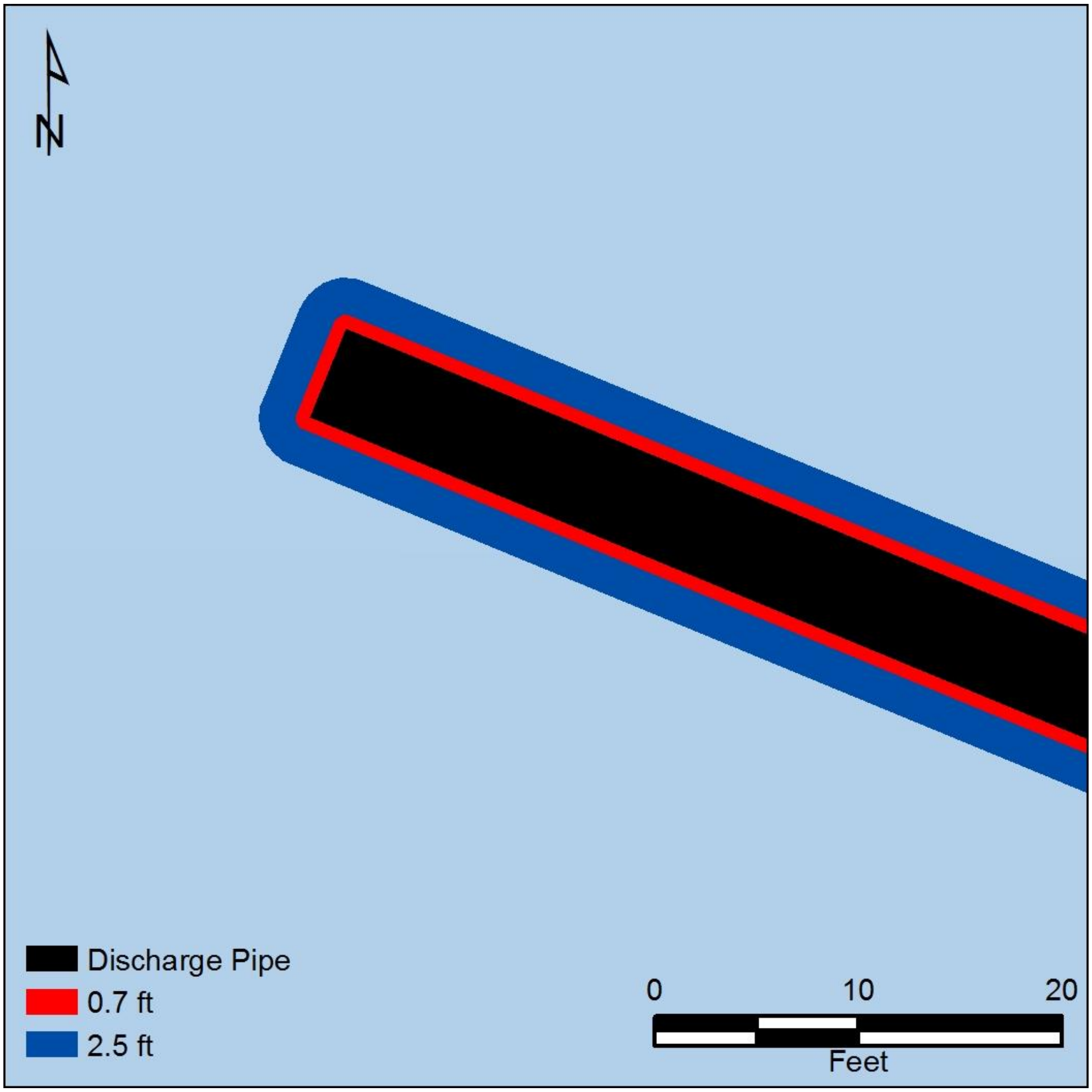

Figure 2. Distance from the discharge pipe for compliance with the 2 ppt regulatory mixing requirement. The red line at 0.7 ft from the pipe approximates the mixing zones for both of the low likelihood mixing scenarios of 3 and 5 MGD of 67 ppt brine with no dilution. The blue line at 2.5 ft from the pipe is the worst-case scenario of 15 MGD of 67 ppt brine with no dilution Note: The pipeline diameter is 4.75 ft.

scenarios the area of benthic exposure >2 ppt above ambient salinity is about 0.2 acres, 1% of the area allowed for this project by the Ocean Plan (SWRCB 2015). For the worst-case scenario the area is still less than one-third of an acre. These area totals are considered the BMZs for the respective scenarios.

Because of the relatively small area of the BMZ for both low-likelihood dense discharge mixing scenarios we will not further parse out detrimental impacts related to acute toxicity or osmotic stresses to benthic organisms that reside within the BMZ. Instead, in these cases we propose basing mitigation on the area of the entire BMZ. We do not suggest that this

Table 1. Area (acres) of benthic exposure >2 ppt above ambient salinity for the two low-likelihood discharge scenarios and for the worst-case scenario.

Dense Discharge Scenario (Jenkins 2019, Table 5)	Wastewater + brine discharge rates (MGD)	Horizontal distance (feet) to within 2 ppt of ambient salinity (Jenkins 2019, Table 5)	Area (acres) of benthic exposure >2 ppt above ambient salinity (BMZ)
1	0 + 3	0.566	0.1999
3	0 + 5	0.653	0.2058
6	0+15	2.466	0.3296

should be set as a precedent, and a case-by-case analysis is recommended, but for this model determining the areas of differential impacts within the BMZ would not substantially change the final mitigation requirements.

As mentioned above, benthic exposure (BMZ) is one of two impacts to the marine environment from the discharge of a dense plume identified by Jenkins (2019). The second impact is stress-related mortality to small, water-column organisms from mechanical mixing of the discharge into the receiving water. Impact areas for stress-related mortality associated with the two low-likelihood dense discharge mixing scenarios were evaluated by the Area of Production Foregone (APF) method in the MBC 6 March 2019 memo. The APF and BMZ area will be considered additive for purposes of determining an area for the basis of evaluating preliminary mitigation requirements. The full area of impact for the two low-likelihood dense discharge mixing scenarios are presented in Table 2. (The worst-case scenario is not further included.) Combined impact area for the 3 MGD discharge scenario is less than four acres and for the 5 MGD discharge scenario less than six acres.

The intent of this memo is to present a methodology and a result for the cumulative area of impact to the marine environment for the low-likelihood dense plume discharge scenarios. Should analysis of the low-likelihood dense plume discharge scenarios move forward, methodology for proposed mitigation for dense-discharge impacts will be presented in subsequent documents.

Table 2. Combined BMZ and APF impact areas (acres) for the determination of mitigation requirements for the two low-likelihood dense plume discharge scenarios.

Dense Discharge Scenario (Jenkins 2019, Table 5)	Wastewater + brine discharge rates (MGD)	Area (acres) of benthic exposure >2 ppt above ambient salinity (BMZ)	Area (acres) Production Foregone (APF)	Combined BMZ and APF area (acres)
1	0 + 3	0.20	3.54	3.74
3	0 + 5	0.21	5.57	5.78

Please let me know if you would like to discuss further.

Cordially,

MBC *Aquatic Sciences*

David Vilas
Senior Scientist

Cc: K. Thomas (Kimley-Horn), D.S. Beck (MBC)

References:

Jenkins, S. 2019. Plumes 18b Modeling Deleterious Diffuser Entrainment Doheny Desalination Project. Prepared for Mark Donovan, GHD, 15 January 2019.

MBC Aquatic Sciences (MBC). 2019. Review of Plumes 18b Modeling Deleterious Diffuser Entrainment Doheny Desalination Project. Memo to Mark Donovan, GHD, dated 6 March 2019.

State Water Resources Control Board (SWRCB). 2015. California Ocean Plan.