March 1, 2018

Dr. Zita Yu, P.E.
West Basin Municipal Water District
17140 South Avalon Blvd., Suite 210
Carson, CA 90746

Subject: Ocean Desalination Project Intake Options Area of Production Forgone Estimates derived from El Segundo Generating Station Clean Water Act Section 316(b) impingement and entrainment characterization study (Tenera and MBC 2008)

Dear Dr. Yu:

I prepared the Area of Production Forgone estimates (APF) for four potential seawater intake scenarios for the West Basin Municipal Water District Ocean Desalination project per our conversation on October 11, 2017 (Table 1). Where possible, I used information contained in El Segundo Generating Station Clean Water Act Section 316(b) impingement and entrainment characterization study (Tenera and MBC 2008) hereafter referred to as the *316(b) report*. From the 316(b) report, I compiled the proportional mortality (P_m) derived using the Empirical Transport Model (ETM) for the El Segundo Generating Station Units 3 & 4 design flow volume, 398.6 million gallons per day (MGD). The design flow assumes constant operation of all cooling water pumps throughout the year; a situation more similar to the proposed ocean water desalination project than the varied cooling water pump operation that actually occurred during the field study supporting the 316(b) report. The same suite of 12 taxa analyzed in the 316(b) report were included in this analysis.

West Basin provided four potential intake volumes to include in the analysis, two per potential project. The local project will produce 20 MGD of potable water with potential seawater intake volumes of 41.0 and 45.3 MGD. A second, larger potential project is being analyzed as well. The second larger, regional project will produce 60 MGD of potable water requiring the intake of 123.0 or 136.2 MGD of seawater. Each of these intake volumes was scaled against the Units 3 & 4 design intake flow volume with the West Basin project options representing percentages ranging from approximately 10% to 34% of the Units 3 & 4 design flow volume.

All ETM parameters were assumed to remain constant except the water volume used to estimate total entrainment. Therefore, the taxon-specific P_m derived for Unit 3 & 4 design flow volume can be scaled for each of the proposed intake volumes for each of the potential projects by multiplying each taxon-specific P_m (from the Units 3 & 4 design flow volume) by each of the four intake flow volume percentages (Equation 1). These resulting four sets of scaled P_m are then multiplied by the taxon-specific APF source water area (Equation 2).

Equation 1:

$$Pm_{WB} = Pm_{ES} \times \frac{Vol_{WB}}{398.6}$$

Where

Pm_{WB} = Proportional mortality at West Basin proposed intake volume

Pm_{ES} = Proportional mortality at El Segundo Generating Station design volume (398.6 million gallons per day

Vol_{WB} = Intake water volume proposed by West Basin

Equation 2:

$$APF_i = Pm_{WB} \times SWA_i$$

Where

APF_i = Area of production foregone for taxon i

Pm_{WB} = Proportional mortality at West Basin proposed intake volume

SWA_i = Taxon i source water area

The APF source water areas were derived by multiplying the maximum alongshore and onshore displacement listed for each taxon in the Tenera and MBC (2008) report (Equation 3). The resulting square kilometer estimate was converted to acres by multiplying by 247.105.

Equation 3:

$$SWA_i = (D_A \times D_O) \times 247.105$$

Where

SWA_i = Taxon i source water area

D_A = Maximum alongshore displacement for taxon *i*

D_O = Maximum onshore displacement for taxon *i*.

The Desalination Amendment to the California Ocean Plan (OPA) allows the Regional Water Quality Control Board the authority to scale mitigation when out-of-kind mitigation is used. In acknowledgement of the range of production each marine habitat is capable of, the OPA allows mitigation scaling when impacts to low-productivity habitat is compensated by the restoration or creation of highly productive habitat. For this reason, all taxa were classified based on their habitat affinities per Allen and Pondella (2006). The APF source water area for all open coast taxa was derived as described above. For taxa with documented affinities to wetlands and estuaries, the APF source water area was set as the available habitat matching that description in the area. These included CIQ goby (a complex of *Clevelandia ios*, *Ilypnus gilberti*, and *Quietula y-cauda*), Combtooth Blennies (*Hypsoblennius* spp.), and Diamond Turbot (*Pleuronichthys guttulatus*). These estimated areas were compiled from the National Wetland Inventory (FWS 2017) using the inventory's marine and estuarine wetland habitat category. Sea Basses (*Paralabrax* spp.) was considered another taxon representative of high productivity habitat, specifically rocky reefs. The two most common Sea Basses, Kelp Bass (*P. clathratus*) and Barred Sand Bass (*P. nebulifer*) commonly occur around rocky reefs for at least part of the year. Barred Sand Bass spend winters near reefs and migrate to soft bottom habitat to form spawning aggregations (Love 2011). Due to their affinity for relatively high-productivity habitat, in comparison to soft-bottom and estuarine, no mitigation scaling was applied to the resulting APF for these four taxa combined. All other taxa were considered representative of either the pelagic or soft-bottom habitats; neither of which is as productive as estuarine habitat.

The resulting APF estimates range from 16.38 to 54.41 acres depending on the intake volume scenario (Table 1). No discounting was applied to account for use of a 1-mm screened intake.

References

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Sincerely,
HDR

Eric Miller
Environmental Project Manager

Table 1. Area of Production Forgone Estimates Derived for Four Potential Seawater Intake Scenarios for the West Basin Municipal Water District Ocean Desalination Project

Scale Group	Scientific Name	Taxa	WB20-41	WB20-45.3	WB60-123	WB60-136.2
1:01	*Paralabrax* spp.	Sea Basses	15.6	17.2	46.8	51.8
1:01	*Hypsoblennius* spp.	Combtooth Blennies	0.6	0.6	1.7	1.9
1:01	*Clevelandia ios/Ilypnus gilbert/Quietula y-cauda*	CIQ	3.1	3.4	9.2	10.2
1:01	*Pleuronichthys guttulatus*	Diamond Turbot	4.3	4.8	12.9	14.3
		Mean	5.9	6.5	17.65	19.55
		Std Err	3.32	3.67	9.99	11.06
		95%CI	11.36	12.54	34.08	37.74
1:10	Engraulidae	Anchovy	66.3	73.2	198.8	220.1
1:10	Atherinopsidae	Silversides	74.1	81.8	222.2	246
1:10	*Genyonemus lineatus*	White Croaker	56.8	62.7	170.3	188.6
1:10	*Seriphus politus*	Queenfish	4.4	4.9	13.3	14.7
1:10	Sciaenidae	Unid. Croakers	36.5	40.3	109.4	121.1
1:10	*Paralichthys californicus*	California Halibut	16.1	17.8	48.3	53.5
1:10	*Citharichthys* spp.	Sanddabs	5.6	6.2	16.9	18.8
1:10	*Parophrys vetulus*	English Sole	6.3	7	19	21
		Mean	33.26	36.74	99.77	110.48
		Std Err	10.3	11.37	30.87	34.18
		95%CI	50.2	55.44	150.55	166.7
		10:1 Scaling	5.02	5.54	15.06	16.67
		Total APF	16.38	18.08	49.14	54.41

March 5, 2018

Subject: **West Basin Municipal Water District Ocean Desalination Project – Review of HDR Area of Production Forgone Estimates Derived from El Segundo Generating Station Clean Water Act Section 316(b) Impingement and Entrainment Characterization Study (Tenera and MBC 2008)**

Environmental Science Associates (ESA) requested that I review an analysis of Area of Production Foregone (APF) conducted by HDR for the West Basin Desalination Project (WBDP). The two primary documents included in my review were a letter report prepared by Eric Miller of HDR briefly describing the methods and results for the APF calculations and an MS Excel spreadsheet with the model inputs and results. Additionally, I reviewed several documents related to Clean Water Act Section 316(b) issues and studies at steam-electric plants with cooling water intake systems (CWIS) in the same general region as the WBDP intake. These documents include 316(b) study reports for the characterization and assessment of impingement and entrainment at the CWIS of the El Segundo Generating Station (ESGS) (Tenera and MBC 2008) located north of the proposed WBDP site, and the Scattergood and Harbor Stations located north and south of ESGS (MBC 1997), respectively. The APF estimates calculated in the HDR analysis were based on proportional mortalities (P_m) developed from Empirical Transport Models (ETM) conducted for ESGS affected species (Tenera and MBC 2008).

HDR's analysis of APF was conducted for four potential WBDP intake flow rates (41.0, 45.3, 123.0, and 136.2 MGD) and was based on ETM results for ESGS Unit 3 & 4, which was estimated to account for more than 80% of total entrainment of fish eggs and larvae and invertebrates at ESGS (Tenera and MBC 2008). The WBDP flow rates were scaled against the design flows for ESGS Units 3 & 4, ranging in percentage from about 10 to 34%. All ETM parameters were assumed to remain constant except the water volume used to estimate total entrainment. HDR concluded that this allowed the P_m of each taxon entrained at Unit 3 & 4 to be scaled to the WBDP flow rates by multiplying each P_m by the flow rate proportions (i.e., 0.103, 0.114, 0.309, and 0.342 for WBDP flow rates of 41.0, 45.3, 123.0, and 136.2 MGD, respectively). Source water areas (SWA) by taxon were calculated by multiplying the sampled source water area reported by Tenera and MBC (2008) by the taxon-specific proportion of the source populations sampled. However, estuary taxa were assigned a standard value based on the area represented in the National Wetland Inventory. The scaled P_m estimates were than multiplied by the SWA's to generate the AFP for each taxon. Mitigation ratios of either 1:1 or 1:10 were applied to each taxon and the mean, SE, and 95% CI were calculated following the methods of Raimondi (2011). The 95% CI for the scale values (i.e., 1:10 mitigation ratio) was divided by 10 and added to the unscaled taxon value for an estimate of total APF.

The methods described above for calculating APF follow standard practices and the analysis used available entrainment and habitat area data that are applicable to WBDP based on geographic proximity of the ESGS intake to the WBDP intake. Scaling the model inputs using the proportional flow of the WBDP withdrawal rates with respect to the ESGS Unit 3 & 4 design flow rate is also a reasonable and valid approach for applying the ESGS data to the assessment of WBDP entrainment impacts (i.e., calculation of WBDP APFs using ESGS data).

The total APF estimated by HDR ranged from approximately 16.4 to 54.4 acres for all taxa combined for the four flow rates under consideration for WBDP. These appear to be valid estimates of the amount of habitat that would be required to replace fish larvae lost to entrainment based on the use of ETM and APF models. However, these models do not address physical and hydraulic and behavioral exclusion of fish larvae by the cylindrical wedgewire screens that will be installed at the intake. When physical exclusion of larvae (and eggs) that are too large to pass through a given slot size *and* hydraulic diversion and behavioral avoidance are considered, potential impacts to ichthyoplankton from the withdrawal of water by WBDP likely will be considerably less than estimated by the ETM and APF models (i.e., which only consider physical exclusion).

The ability of cylindrical wedgewire screens to reduce entrainment of ichthyoplankton has been extensively evaluated in laboratory and field studies. These evaluations have demonstrated that high rates of exclusion can occur for fish eggs and larvae, even when these organisms are small enough to pass through slot openings (i.e., entrainment rates are lower than would be predicted by physical exclusion alone). In general, wedgewire screen exclusion is dependent on slot width, through-slot velocity, and ambient currents approaching and passing by a screen (Amaral et al. 2004). Recent laboratory studies conducted with ichthyoplankton of several fish species identified the following four mechanisms as contributors to the biological efficacy of cylindrical wedgewire screens (as summarized by Coutant 2014 and reported by NAI and ASA 2011a,b):

- *Hydraulic bypass*: Hydraulic diversion of eggs and larvae away from nose cone of screen (upstream end) by bow wave (assumes screens are oriented parallel to ambient or prevailing currents).

- *Behavioral avoidance*: Active avoidance by fish larvae in response to hydraulic cues (e.g., changes in pressure or flow acceleration) and/or physical screen components.

- *Physical Exclusion*: Exclusion of organisms which are physically too large to pass through a slot opening. NAI and ASA (2011a, b) concluded the effect of physical exclusion on overall entrainment rates was relatively minor (i.e., hydraulic bypass and behavioral avoidance observed for smaller organisms had greater contributions to screening efficiency).

- *Sweep off*: Movement of impinged eggs and larvae, or those that come into contact with the screen, along the screen face due to ambient current (sweeping flow). Similar to physical exclusion, this mechanism was also determined to have a relatively minor effect on overall screening efficiency rates.

The information and data from biological evaluations of cylindrical wedgewire screens, as described above, demonstrate that using physical exclusion as the only metric to define ichthyoplankton entrainment probability, and thus mortality, is overly conservative.

Please contact me if you have any questions regarding my review or if you need any additional information that I may be able to provide.

Sincerely,

Stephen V. Amaral
Principal Fisheries Biologist
Alden Research Laboratory, Inc.

References

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